RAILROAD CURVES

AND

EARTHWORK

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PREFACE.

THIS book was prepared for the use of the students in the author's classes. It has been used in lithographed sheets for a number of years in very nearly the present form, and has given satisfaction sufficient to suggest putting it in print. An effort has been made to have the demonstrations simple and direct, and special care has been given to the arrangement and the typography, in order to secure clearness and conciseness of mathematical statement. Much of the material in the earlier part of the book is necessarily similar to that found in one or more of several excellent field books, although the methods of demonstration are in many cases new. This will be found true especially in Compound Curves, for which simple treatment has been found quite possible. New material will be found in the chapters on Turnouts and on "Y" Tracks and Crossings. The Spiral Easement Curve is treated originally. The chapters on Earthwork are essentially new; they include Staking Out; Computation, directly and with Tables and Diagrams; also Haul, treated ordinarily and by Mass Diagram. Most of the material relating to Earthwork is not elsewhere readily available for students' use.

The book has been written especially to meet the needs of students in engineering colleges, but it is probable that it will be found useful by many engineers in practice. The size of page allows it to be used as a pocket book in the field. It is difficult to avoid typographical and clerical errors; the author will consider it a favor if he is notified of any errors found to exist.

C. FRANK ALLEN.

BOSTON,
September, 1899.

PREFACE TO FIFTH EDITION

THE revision of this edition has been extensive. Few pages dealing with curves have escaped some change. In considerable part it has been a matter of refining or clearing up points shown by teaching to admit of improvement. A considerable amount of new material has been added and a few less important problems omitted; by rearrangement, and condensation in places, the size of the book has not been appreciably increased. The chapter on Turnouts has been almost completely rewritten; railroad practice in Turnouts has progressed materially in late years and complete revision of this chapter seemed advisable. The chapter on Connecting Tracks and Crossings has been materially extended. The chapter on Spirals has largely been rewritten and adapted to the use of the Spiral of the American Railway Engineering Association, the merits of which appeal to the author aside from the official sanction which establishes it as standard. A few, but not many, important changes have been made in the chapters on Earthwork.

It is still true that while this text was prepared primarily for students, nevertheless this book has proved to be well adapted to the requirements of the practicing railroad engineer or other engineer who has to deal with curves or with earthwork computation.

C. FRANK ALLEN.

January, 1914.

CONTENTS.

CHAPTER I.

Reconnoissance.

CHAPTER II.

Preliminary Survey.

CHAPTER III.

Location Survey.

CHAPTER IV.

Simple Curves.

CHAPTER V.

Compound Curves.

CHAPTER IX.

Connecting Tracks and Crossings.

CHAPTER X.

Spiral Easement Curve.

CHAPTER XI.

Setting Stakes for Earthwork.

CHAPTER XII.

Methods of Computing Earthwork.

CHAPTER XIII.

Special Problems in Earthwork.

CHAPTER XIV.

Earthwork Tables.

CHAPTER XV.

Earthwork Diagrams.

CHAPTER XVI.

Haul.

CHAPTER XVII.

Mass Diagram.

RAILROAD CURVES AND EARTHWORK.

CHAPTER I.

1. The operations of "locating" a railroad, as commonly practiced in this country, are three in number: —

I. RECONNOISSANCE.
II. PRELIMINARY SURVEY.
III. LOCATION SURVEY.

I. RECONNOISSANCE.

2. The Reconnoissance is a rapid survey, or rather a critical examination of country, without the use of the ordinary instruments of surveying. Certain instruments, however, are used, the Aneroid Barometer, for instance. It is very commonly the case that the termini of the railroad are fixed, and often intermediate points also. It is desirable that no unnecessary restrictions as to intermediate points should be imposed on the engineer to prevent his selecting what he finds to be the best line, and for this reason it is advisable that the reconnoissance should, where possible, precede the drawing of the charter.

3. The first step in reconnoissance should be to procure the best available maps of the country; a study of these will generally furnish to the engineer a guide as to the routes or section of country that should be examined. If maps of the United States Geological Survey are at hand, with contour lines and other topography carefully shown, the reconnoissance can be largely determined upon these maps. Lines clearly impracticable will be thrown out, the maximum grade closely determined, and the field examinations reduced to a minimum No

route should be accepted finally from any such map, but a careful field examination should be made over the routes indicated on the contour maps. The examination, in general, should cover the general section of country, rather than be confined to a single line between the termini. A straight line and a straight grade from one terminus to the other is desirable, but this is seldom possible, and is in general far from possible. If a single line only is examined, and this is found to be nearly straight throughout, and with satisfactory grades, it may be thought unnecessary to carry the examination further. It will frequently, however, be found advantageous to deviate considerably from a straight line in order to secure satisfactory grades. In many cases it will be necessary to wind about more or less through the country in order to secure the best line. Where a high hill or a mountain lies directly between the points, it may be expected that a line around the hill, and somewhat remote from a direct line, will prove more favorable than any other. Unless a reasonably direct line is found, the examination, to be satisfactory, should embrace all the section of intervening country, and all feasible lines should be examined.

4. There are two features of topography that are likely to prove of especial interest in reconnoissance, *ridge lines* and *valley lines.*

A *ridge line* along the whole of its course is higher than the ground immediately adjacent to it on each side. That is, the ground slopes downward from it to both sides. It is also called a *watershed line.*

A *valley line*, to the contrary, is lower than the ground immediately adjacent to it on each side. The ground slopes upward from it to both sides. Valley lines may be called *watercourse lines.*

A *pass* is a place on a ridge line lower than any neighboring points on the same ridge. Very important points to be determined in reconnoissance are the passes where the ridge lines are to be crossed; also the points where the valleys are to be crossed; and careful attention should be given to these points. In crossing a valley through which a large stream flows, it may be of great importance to find a good bridge crossing. In some cases where there are serious difficulties in crossing a ridge, a tunnel may be necessary. Where such structures, either

bridges or tunnels, are to be built, favorable points for their construction should be selected and the rest of the line be compelled to conform. In many parts of the United States at the present time, the necessity for avoiding grade crossings causes the crossings of roads and streets to become governing points of as great importance as ridges and valleys.

5. There are several purposes of reconnoissance: first, to find whether there is any satisfactory line between the proposed termini; second, to establish which of several lines is best; third, to determine approximately the maximum grade necessary to be used; fourth, to report upon the character or geological formation of the country, and the probable cost of construction depending somewhat upon that; fifth, to make note of the existing resources of the country, its manufactures, mines, agricultural or natural products, and the capabilities for improvement and development of the country resulting from the introduction of the railroad. The report upon reconnoissance should include information upon all these points. It is for the determination of the third point mentioned, the rate of maximum grade, that the barometer is used. Observing the elevations of governing points, and knowing the distances between those points, it is possible to form a good judgment as to what rate of maximum grade to assume.

6. The Elevations are usually taken by the *Aneroid Barometer.* Tables for converting barometer readings into elevations above sea-level are readily available and in convenient form for field use. (See Table XI., Allen's Field and Office Tables.)

Distances may be determined with sufficient accuracy in many cases from the map, where a good one exists. Where this method is impossible or seems undesirable, the distance may be determined in one of several different ways. When the trip is made by wagon, it is customary to use an *Odometer*, an instrument which measures and records the number of revolutions of the wheel to which it is attached, and thus the distance traveled by the wagon. There are different forms of odometer. In its most common form, it depends upon a hanging weight or pendulum, which is supposed to hold its position, hanging vertical, while the wheel turns. The instrument is attached to the wheel between the spokes and as near to the hub as practicable. At low speeds it registers accurately; as the

speed is increased, a point is reached where the centrifugal force neutralizes or overcomes the force of gravity upon the pendulum, and the instrument fails to register accurately, or perhaps at high speeds to register at all. If this form of odometer is used, a clear understanding should be had of the conditions under which it fails to correctly register. A theoretical discussion might closely establish the point at which the centrifugal force will balance the force of gravity. The wheel striking against stones in a rough road will create disturbances in the action of the pendulum, so that the odometer will fail to register accurately at speeds less than that determined upon the above assumption.

A cyclometer, manufactured for automobile use, is connected both with the wheel and the axle, and so measures positively the relative motion between the wheel and axle, and this ought to be reliable for registering accurately. Many engineers prefer to count the revolutions of the wheel themselves, tying a rag to the wheel to make a conspicuous mark for counting.

When the trip is made on foot, pacing will give satisfactory results. An instrument called the *Pedometer* registers the results of pacing. As ordinarily constructed, the graduations read to quarter miles, and it is possible to estimate to one-tenth that distance. Pedometers are also made which register paces. In principle, the pedometer depends upon the fact that, with each step, a certain shock or jar is produced as the heel strikes the ground, and each shock causes the instrument to register. Those registering miles are adjustable to the length of pace of the wearer.

If the trip is made on horseback, it is found possible to get good results with a steady-gaited horse, by first determining his rate of travel and figuring distance by the time consumed in traveling. Excellent results are said to have been secured in this way.

7. It is customary for engineers not to use a compass in reconnoissance, although this is sometimes done in order to trace the line traversed upon the map, and with greater accuracy. A pocket level will be found useful. The skillful use of pocket instruments will almost certainly be found of great value to the engineer of reconnoissance.

It may, in cases, occur that no maps of any value are in existence or procurable. It may be necessary, in such a case, to make a rapid instrumental survey, the measurements being taken either by pacing, chain, or stadia measurements. This is, however, unusual.

8. The preliminary survey is based upon the results of the reconnoissance, and the location upon the results of the preliminary survey. The reconnoissance thus forms the foundation upon which the location is made. Any failure to find a suitable line and the best line constitutes a defect which no amount of faithfulness in the later work will rectify. The most serious errors of location are liable to be due to imperfect reconnoissance; an inefficient engineer of reconnoissance should be avoided at all hazards. In the case of a new railroad, it would, in general, be proper that the Chief Engineer should in person conduct this survey. In the case of the extension of existing lines, this might be impracticable or inadvisable, but an assistant of known responsibility, ability, and experience should in this case be selected to attend to the work.

CHAPTER II.

II. PRELIMINARY SURVEY.

9. The Preliminary Survey is based upon the results of the reconnoissance. It is a survey made with the ordinary instruments of surveying. Its purpose is to fix and mark upon the ground a first trial line approximating as closely to the proper final line as the difficulty of the country and the experience of the engineer will allow; further than this, to collect data such that this survey shall serve as a basis upon which the final Location may intelligently be made. In order to approximate closely in the trial line, it is essential that the maximum grade should be determined or estimated as correctly as possible, and the line fixed with due regard thereto.

It will be of value to devote some attention here to an explanation about Grades and "Maximum Grades."

10. Grades. — The ideal line in railroad location is a straight and level line. This is seldom, if ever, realized. When the two termini are at different elevations, a line straight and of uniform grade becomes the ideal. It is commonly impossible to secure a line of uniform grade between termini. In operating a railroad, an engine division will be about 100 miles, sometimes less, often more. In locating any 100 miles of railroad, it is almost certain that a uniform grade cannot be maintained. More commonly there will be a succession of hills, part of the line up grade, part down grade. Sometimes there will be a continuous up grade, but not at a uniform rate. With a uniform grade, a locomotive engine will be constantly exerting its maximum pull or doing its maximum work in hauling the longest train it is capable of hauling; there will be no power wasted in hauling a light train over low or level grades upon which a heavier train could be hauled. Where the grades are not uniform, but are rising or falling, or rising irregularly, it will be found that the topography on some particular 5 or 10

miles is of such a character that the grade here must be steeper than is really necessary anywhere else on the line; or there may be two or three stretches of grade where about the same rate of grade is necessary, steeper than elsewhere required. The steep grade thus found necessary at some special point or points on the line of railroad is called the "Maximum Grade" or "Ruling Grade" or "Limiting Grade," it being the grade that limits the weight of train that an engine can haul over the whole division. It should then be the effort to make the rate of maximum grade as low as possible, because the lower the rate of the maximum grade, the heavier the train a given locomotive can haul, and because it costs not very much more to haul a heavy train than a light one. The maximum grade determined by the reconnoissance should be used as the basis for the preliminary survey. How will this affect the line? Whenever a hill is encountered, if the maximum grade be steep, it may be possible to carry the line straight, and over the hill; if the maximum grade be low, it may be necessary to deflect the line and carry it around the hill. When the maximum grade has been once properly determined, if any saving can be accomplished by using it rather than a grade less steep, the maximum grade should be used. It is possible that the train loads will not be uniform throughout the division. It will be advantageous to spend a small sum of money to keep any grade lower than the maximum, in view of the *possibility* that at this particular point the train load will be heavier than elsewhere on the division. Any saving made will in general be of one or more of three kinds:—

a. Amount or "quantity" of excavation or embankment;
b. Distance;
c. Curvature.

11. In some cases, a satisfactory grade, a low grade for a maximum, can be maintained throughout a division of 100 miles in length, with the exception of 2 or 3 miles at one point only. So great is the value of a low maximum grade that all kinds of expedients will be sought for, to pass the difficulty without increasing the rate of maximum grade, which we know will apply to the whole division.

12. Sometimes by increasing the length of line, we are able to reach a given elevation with a lower rate of grade. Some-

times heavy and expensive cuts and fills may serve the purpose. Sometimes all such devices fail, and there still remains necessary an increase of grade at this one point, but at this point only. In such case it is now customary to adopt the higher rate of grade for these 2 or 3 miles and operate them by using an extra or additional engine. In this case, the "ruling grade" for the division of 100 miles is properly the "maximum grade" prevailing over the division generally, the higher grade for a few miles only being known as an "Auxiliary Grade" or more commonly a "Pusher Grade." The train which is hauled over the engine division is helped over the auxiliary or pusher grade by the use of an additional engine called a "Pusher." Where the use of a short "Pusher Grade" will allow the use of a low "maximum grade," there is evident economy in its use. The critical discussion of the importance or value of saving distance, curvature, rise and fall, and maximum grade, is not within the scope of this book, and the reader is referred to Wellington's "Economic Theory of Railway Location."

13. The Preliminary Survey follows the general line marked out by the reconnoissance, but this rapid examination of country may not have fully determined which of two or more lines is the best, the advantages may be so nearly balanced. In this case two or more preliminary surveys must be made for comparison. When the reconnoissance has fully determined the general route, certain details are still left for the preliminary survey to determine. It may be necessary to run two lines, one on each side of a small stream, and possibly a line crossing it several times. The reconnoissance would often fail to settle minor points like this. It is desirable that the preliminary survey should closely approximate to the final line, but it is not important that it should fully coincide anywhere.

An important purpose of the "preliminary" is to provide a map which shall show enough of the topography of the country, so that the Location proper may be projected upon this map. Working from the line of survey as a base line, measurements should be taken sufficient to show streams and various natural objects as well as the contours of the surface.

14. The Preliminary Survey serves several purposes: —

First. To fix accurately the maximum grade for use in Location.

Second. To determine which of several lines is best.

Third. To provide a map as a basis upon which the Location can properly be made.

Fourth. To make a close estimate of the cost of the work.

Fifth. To secure, in certain cases, legal rights by filing plans.

15. It should be understood that the preliminary survey is, in general, simply a means to an end, and rapidity and economy are desirable. It is an instrumental survey. Measurements of distance are taken usually with the chain, although a tape is sometimes used. Angles are taken generally with a transit; some advocate the use of a compass. The line is ordinarily run as a broken line with angles, but is occasionally run with curves connecting the straight stretches, generally for the reason that a map of such a line is available for filing, and certain legal rights result from such a filing. With a compass, no backsight need be taken, and, in passing small obstacles, a compass will save time on this account. A transit line can be carried past an obstacle readily by a zigzag line. Common practice among engineers favors the use of the transit rather than the compass. Stakes are set, at every "Station," 100 feet apart, and the stakes are marked on the face, the first 0, the next 1, then 2, and so to the end of the line. A stake set 1025 feet from the beginning would be marked 10 + 25.

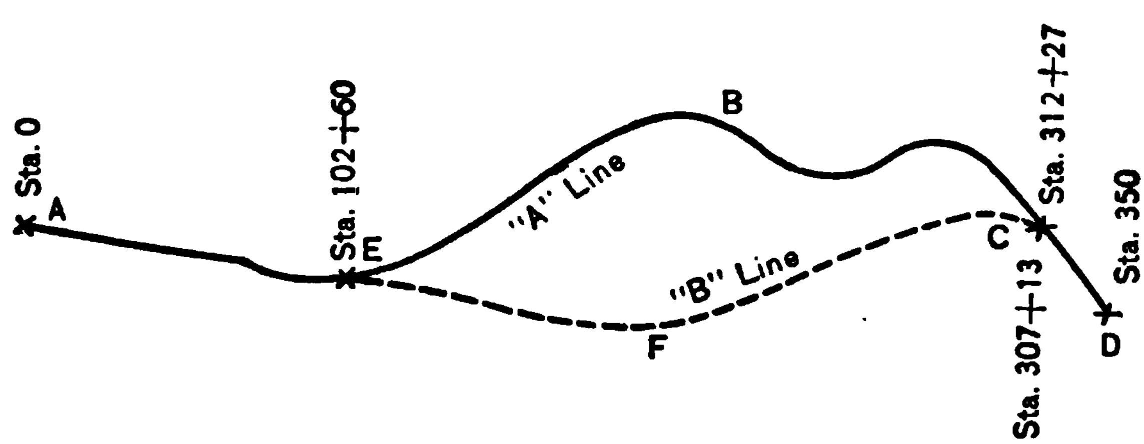
Levels are taken on the ground at the side of the stakes, and as much oftener as there is any change in the inclination of the ground. All the surface heights are platted on a profile, and the grade line adjusted.

16. The line should be run from a governing point towards country allowing a choice of location, that is from a pass or from an important bridge crossing, towards country offering no great difficulties. There is an advantage in running from a summit downhill, subject, however, to the above considerations. In running from a summit down at a prescribed rate of grade, an experienced engineer will carry the line so that, at the end of a day's work, the levels will show the line to be about where it ought to be. For this purpose, the levels must be worked up and the profile platted to date at the close of each day. Any slight change of line found necessary can then be made early the next morning. A method sometimes adopted in working down from a summit is for the locating engineer to

plat his grade line on the profile, daily in advance, and then during the day, plat a point on his profile whenever he can conveniently get one from his leveler, and thus find whether his line is too high or too low.

17. Occasionally the result of two or three days' work will yield a line extremely unsatisfactory, enough so that the work of these two or three days will be abandoned. The party "backs up" and takes a fresh start from some convenient point. In such case the custom is not to tear out several pages of note-book, but instead to simply draw a line across the page and mark the page "Abandoned." At some future time the abandoned notes may convey useful information to the effect that this line was attempted and found unavailable. In general, all notes worth taking are worth saving.

Sometimes after a line has been run through a section of country, there is later found a shorter or better line.



In the figure used for illustration, the first line, "A" Line, is represented by AEBCD, upon which the stations are marked continuously from A to D, 350 stations. The new line, "B" Line, starts from E, Sta. 102 + 60, and the stationing is held continuous from O to where it connects with the "A" Line at C. The point C is Sta. 312 + 27 of the "A" Line, and is also Sta. 307 + 13 of the "B" Line. It is not customary to restake the line from C to D in accordance with "B" Line stationing. Instead of this, a note is made in the note-books as follows: —

Sta. 312 + 27 "A" Line = 307 + 13 "B" Line.

Some engineers make the note in the following form: —

Sta. 307 to 313 = 86 ft.

The first form is preferable, being more direct and less liable to cause confusion.

18. All notes should be kept clearly and nicely in a note-book — never on small pieces of paper. The date and the names of members of the party should be entered each day in the upper left-hand corner of the page. An office copy should be made as soon as opportunity offers, both for safety and convenience. *The original notes should always be preserved;* they would be admissible as evidence in a court of law where a copy would be rejected. When two or more separate or alternate lines are run, they may be designated

Line "A," Line "B," Line "C,"

or "A" Line, "B" Line, "C" Line.

19. The Organization of Party may be as follows: —

1. Locating Engineer.	
2. Transitman. 3. Head Chainman. 4. Stakeman. 5. Rear Chainman. 6. Back Flag. 7. Axemen (one or more).	Transit Party.
8. Leveler. 9. Rodman (sometimes two).	Level Party.
10. Topographer. 11. Assistant.	Topographical Party
12. Cook.	
13. Teamster.	

20. The Locating Engineer is the chief of party, and is responsible for the business management of the camp and party, as well as for the conduct of the survey. He determines where the line shall run, keeping ahead of the transit, and establishing points as foresights or turning-points for the transitman. In open country, the extra axeman can assist by holding the flag at turning-points, and thus allowing the locating engineer to push on and pick out other points in advance. The locating engineer keeps a special note-book or memorandum book; in it he notes on the ground the quality of material, rock, earth, or whatever it may be; takes notes to determine the lengths and positions of bridges, culverts, and other structures; shows the localities of timber, building stones, borrow pits, and

other materials valuable for the execution of the work; in fact, makes notes of all matters not properly attended to by the transit, leveling, or topography party. The rapid and faithful prosecution of the work depend upon the locating engineer, and the party ought to derive inspiration from the energy and vigor of their chief, who should be the leader in the work. In open and easy country, the locating engineer may instill life into the party by himself taking the place of the head chainman occasionally. In country of some difficulty, his time will be far better employed in prospecting for the best line.

21. The Transitman does the transit work, ranges in the line from the instrument, measures the angles, and keeps the notes of the transit survey. The following is a good form for the left-hand page of the note-book: —

Station	Point	Deflection	Observed Bearing	Calculated Bearing
7			N 3° 30′ E	N 3° 38′ E
	⊙ + 24	33° 02′ R		
6				
5			N 29° 30′ W	N 29° 24′ W
4	⊙	12° 09′ L		
3				
2				
1			N 17° 15′ W	N 17° 15′ W
0	⊙			

Notes of topography and remarks are entered on the right-hand page, which, for convenience, is divided into small squares by blue lines, with a red line running up and down through the middle.

The stations run from bottom to top of page. The bearing is taken at each setting and recorded *just above* the corresponding point in the note-book, or opposite a part of the line, rather than opposite the point. Ordinarily, the transitman takes the bearings of all fences and roads crossed by the line, finds the stations from the rear chainman, and records them in their proper place and direction on the right-hand page of the note-book. Section lines of the United States Land Surveys should be

observed in the same way. The transitman is next in authority to the locating engineer, and directs the work when the latter is not immediately present. The transitman, while moving from point to point, setting up, and ranging line, limits the speed of the entire party, and should waste no time.

22. The Head Chainman carries a "flag" and the forward end of the tape, which should be held level and firm with one hand, while the flag is moved into line with the other. He should always put himself nearly in line before receiving a signal from the transitman; plumbing may be done with the flag. When the point is found, the stakeman will set the stake. When a suitable place for a turning-point is reached, a signal should be given the transitman to that effect. A nail should be set in top of a "plug" at all turning-points. A proper understanding should be had with the transitman as to signals.

Signals from the Transitman.

A horizontal movement of the hand indicates that the rod should be moved as directed.

A swinging movement of the hand, "Plumb the rod as indicated."

A movement of both hands, or waving the handkerchief freely above the head, means "All right."

At long distances, a handkerchief can be seen to advantage; when snow is on the ground, something black is better.

Signals from the Head Chainman.

Setting the bottom of flag on the ground and waving the top, means "Give the line."

Raising the flag above the head and holding it horizontal with both hands: "Give line for a turning-point."

The "all right" signal is the same as from the transitman.

In all measurements less than 100 feet (or a full tape), the head chainman holds the end of the tape, leaving the reading of the measurement to the rear chainman.

The head chainman regulates the speed of the party during the time that the instrument is in place, and should keep alive all the time. The rear chainman will keep up as a matter of necessity.

23. The Stakeman carries, marks, and drives the stakes at the points indicated by the head chainman. The stakes should

be driven with the flat side towards the instrument, and marked on the front with the number of the station. Intermediate stakes should be marked with the number of the last station + the additional distance in feet and tenths, as 10 + 67.4. The stationing is not interrupted and taken up anew at each turning-point, but is continuous from beginning to end of the survey. At each turning-point a plug should be driven nearly flush with the ground, and a witness stake driven, in an inclined position, at a distance of about 15 inches from the plug, and at the side towards which the advance line deflects, and marked W and under it the station of the plug.

24. The Rear Chainman holds the rear end of the tape over the stake last set, but does not hold against the stake to loosen it. He calls "Chain" each time when the new stake is reached, being careful not to overstep the distance. He should stand beside the line (not on it) when measuring, and take pains not to obstruct the view of the transitman. He checks, and is responsible for the correct numbering of stakes, and for all distances less than 100 feet, as the head chainman always holds the end of the tape. The stations where the line crosses fences, roads, and streams should be set down in a small note-book, and reported to the transitman at the earliest convenient opportunity. The rear chainman is responsible for the tape.

25. The Back Flag holds the flag as a backsight at the point last occupied by the transit. The only signals necessary for him to understand from the transitman are "plumb the flag" and "all right." The flag should always be in position, and the transitman should not be delayed an instant. The back flag should be ready to come up the instant he receives the "all right" signal from the transitman. The duties are simple, but frequently are not well performed.

26. The Axeman cuts and clears through forest or brush. A good axeman should be able to keep the line well, so as to cut nothing unnecessary. In open country, he prepares the stakes ready for the stakeman or assists the locating engineer as *fore flag*.

27. The Leveler handles the level and generally keeps the notes, which may have the following form for the left-hand page. The right-hand page is for remarks and descriptions of turning-points and bench-marks. It is desirable that turning-

Station	+ S	H I	− S	Elevation
B.M.	4.67	104.67		100.00
0			5.7	99.0
1			6.9	97.8
2			3.4	101.3
T.P.	9.26	112.81	1.12	103.55
3			8.5	104.3

points should, where possible, be described, and that all bench-marks should be used as turning-points. Readings on turning-points should be recorded to hundredths or to thousandths of a foot, dependent upon the judgment of the Chief Engineer. Surface readings should be made to the nearest tenth, and elevations set down to nearest tenth only. A self-reading rod has advantages over a target rod for short sights. A target rod is possibly better for long sights and for turning-points. The "Philadelphia Rod" is both a target rod and a self-reading rod, and is thus well adapted for railroad use. Bench-marks should be taken at distances of from 1000 to 1500 feet, depending upon the country. All bench-marks, as soon as calculated, should be entered together on a special page near the end of the book. The leveler should test his level frequently to see that it is in adjustment. The leveler and rodman should together bring the notes to date every evening and plat the profile to correspond.

The profile of the preliminary line should show: —

a. Surface line (in black).
b. Grade line (in red).
c. Grade elevations at each change in grade (in red).
d. Rate of grade, per 100 (in red); rise +, fall −.
e. Station and deflection at each angle in the line (in black).
f. Notes of roads, ditches, streams, bridges, etc. (in black).

28. The Rodman carries the rod and holds it vertical upon the ground at each station and at such intermediate points as mark any important change of slope of the ground. The surface of streams and ponds should be taken when met, and at frequent intervals where possible, if they continue near the line.

Levels should also be taken of high-water marks wherever traces of these are visible. The rodman carries a small note-book in which he enters the rod readings at all turning-points. In country which is open, but not level, the transit party is liable to outrun the level party. In such cases greater speed will be secured by the use of two rodmen.

29. The Topographer is, or should be, one of the most valuable members of the party. In times past it has not always been found necessary to have a topographer, or if employed, his duty has been to sketch in the general features necessary to make an attractive map, and represent hills and buildings sufficiently well with reference to the line to show, in a general way, the reason for the location adopted. Sometimes the chief of the party has for this purpose taken the topography. At present the best practice favors the taking of accurate data by the topography party.

The topographer (with one or two assistants) should take the station and bearing (or angle) of every fence or street line crossed by the survey (unless taken by the transit party); also take measurements and bearings for platting all fences and buildings near enough to influence the position of the Location; also sketch, as well as may be, fences, buildings, and other topographical features of interest which are too remote to require exact location; and finally establish the position of contour lines, streams, and ponds, within limits such that the Location may be properly determined in the contoured map.

The work of locating contours is usually accomplished by the use of hand level and tape (distances carefully paced may, in many cases, be sufficiently accurate). The level party has determined the elevations of the ground at each "station" set by the transit party. These elevations are given the topographers to serve as bench marks for use in locating contours. It is customary to fix on the ground the points where the contours cross the center line, where they cross lines at right angles to the center line at each station, and occasionally additional points; then to sketch the contours by eye between these points. Cross section sheets in blocks or in book form are used for this purpose. The usual contour interval is 5 feet.

A point on a contour is found as follows. The topographer stands at the station stake; a measurement is taken, by tape

or rod, of the distance from the topographer's feet to his eye; this added to the surface height at center stake (as obtained from the level party) gives the "height of eye" above datum. The difference between this "height of eye" and the elevation of the contour gives the proper rod reading for fixing a point on the contour, and the rod is carried vertically along the ground until this reading is obtained. The point thus found is then located. The topographer uses this point, already fixed, as a turning point, finds anew his "height of eye," and proceeds to find a point on the next contour. It is more convenient at times to carry on the process in reverse order; that is, to hold the rod on the ground at the station, and let the topographer place himself where his feet are on the contour. The "height of eye" must be the distance from topographer's feet to eye added to the elevation of contour. The rod reading at the station will be the difference between this "height of eye" and the elevation of the ground at the station.

The hand level is somewhat lacking in precision, but by making a fresh start at each station as a bench mark, cumulative errors are avoided, and fair results secured by careful work. Instead of a hand level, some topographers use a clinometer, and take and record side slopes as a basis for contour lines.

Topography can be taken rapidly and well by stadia survey or by plane table. This is seldom done, as many engineers are not sufficiently familiar with their use. Much more accurate results may be reached by plane table, and a party of three, well skilled in plane table work, will accomplish more than a party of three with hand level.

30. Some engineers advocate making a general topographical survey of the route by stadia, instead of the survey above described. In this case no staking out by "stations" would be done. All points occupied by the transit should be marked by plugs properly referenced, which can be used to aid in marking the Location on the ground after it is determined on the contour map. This method has been used a number of times, and is claimed to give economical and satisfactory results; it is probable that it will have constantly increasing use in the future, and may prove the best method in a large share of cases.

CHAPTER III.

III. LOCATION SURVEY.

31. The Location Survey is the final fitting of the line to the ground. In Location, curves are used to connect the straight lines or "tangents," and the alignment is laid out complete, ready for construction.

The party is much the same as in the preliminary, and the duties substantially the same. More work devolves upon the transitman on account of the curves, and it is good practice to add a "note-keeper" to the party; he takes some of the transitman's work, and greater speed for the entire party is secured. More skill is useful in the head chainman in putting himself in position on curves. He can readily range himself on tangent. The form of notes will be shown later. The profile is the same, except that it shows, for alignment notes, the *P.C.* and *P.T.* of curves, and also the degree and central angle, and whether to the right or left.

It is well to connect frequently location stakes with preliminary stakes, when convenient, as a check on the work.

In making the location survey, two distinct methods are in use among engineers: —

32. First Method of Location. — Use preliminary survey and preliminary profile as guides in reading the country, and locate the line upon the ground. Experience will enable an engineer to get very satisfactory results in this way, in nearly all cases. The best engineers, in locating in this way, as a rule lay the tangents first, and connect the curves afterwards.

33. Second Method. — Use preliminary line, preliminary profile, and especially the contour lines on the preliminary map; make a paper location, and run this in on the ground. Some go so far as to give their locating engineer a complete set of notes to run by. This is going too far. It is sufficient to fix,

on the map, the location of tangents, and specify the degree of curve. The second method is much more desirable, but the first method has still some use. It is well accepted, among engineers, that no reversed curve should be used; 200 feet of tangent, at least, should intervene. Neither should any curve be very short, say less than 300 feet in length.

34. A most difficult matter is the laying of a long tangent, so that it shall be straight. Lack of perfect adjustment and construction of instrument will cause a "swing" in the tangent. The best way is to run for a distant foresight. Another way is to have the transit as well adjusted as possible, and even then change ends every time in reversing, so that errors shall not accumulate. It will be noticed that the preliminary is run in without curves because more economical in time; sometimes curves are run however, either because the line can be run closer to its proper position, or sometimes in order to allow of filing plans with the United States or separate States.

35. In Location, a single tangent often takes the place of a broken line in the preliminary, and it becomes important to determine the direction of the tangent with reference to some part of the broken line. This is readily done by finding the coördinates of any given point with reference to that part of the broken line assumed temporarily as a meridian. The course of each line is calculated, and the coördinates of any point thus found. It simplifies the calculation to use some part of the preliminary as an assumed meridian, rather than to use the actual bearings of the lines. The coördinates of two points on the proposed tangent allow the direction of the tangent to be determined with reference to any part of the preliminary. When the angles are small, an approximation sufficiently close will be secured, by assuming in all cases that the cosine of the angle is 1.000000 and that the sines are directly proportional to the angles themselves. In addition to this, take the distances at the nearest even foot, and the calculation becomes much simplified.

36. The located line, or "Location," as it is often called, is staked out ordinarily by center stakes which mark a succession of straight lines, connected by curves to which the straight lines are tangent. The straight lines are by general usage called "**Tangents.**"

CHAPTER IV.

SIMPLE CURVES.

37. The curves most generally in use are circular curves, although parabolic and other curves are sometimes used. Circular curves may be classed as **Simple**, **Compound**, **Reversed**, or **Spiral**.

A Simple Curve is a circular arc, extending from one tangent to the next. The point where the curve leaves the first tangent is called the "*P. C.*," meaning the point of curvature, and the point where the curve joins the second tangent is called the "*P. T.*," meaning the point of tangency. The *P. C.* and *P. T.* are often called the Tangent Points. If the tangents be produced, they will meet in a point of intersection called the "**Vertex**," *V*. The distance from the vertex to the *P. C.* or *P. T.* is called the "**Tangent Distance**," *T*. The distance from the vertex to the curve (measured towards the center) is called the **External Distance**, *E*. The line joining the middle of the **Chord**, *C*, with the middle of the curve subtended by this chord, is called the **Middle Ordinate**, *M*. The radius of the curve is called the **Radius**, *R*. The angle of deflection between the tangents is called the **Intersection Angle**, *I*. The angle at the center subtended by a chord of 100 feet is called the **Degree of Curve**, *D*. A chord of less than 100 feet is called a **sub-chord**, *c*; its central angle a **sub-angle**, *d*.

38. The measurements on a curve are made:

(*a*) from *P. C.* by a sub-chord (sometimes a full chord of 100 ft.) to the next full station, then

(*b*) by chords of 100 feet each between full stations, and finally,

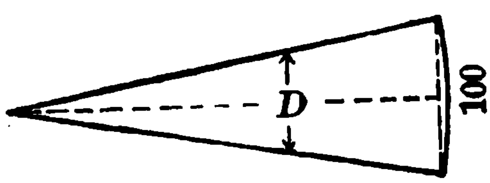
(*c*) from the last station on the curve, by a sub-chord (sometimes a full chord of 100 ft.) to *P. T.* The total distance from *P. C.* to *P. T.* *measured in this way*, is the **Length of Curve**, *L*.

39. The **Degree of Curve** is defined as the angle subtended by a *chord* of 100 feet, rather than by an *arc* of 100 feet.

Either assumption requires approximate methods either in calculations or measurements, if the convenient and customary methods are followed. On the merits of the question, it is best to accept the definition given, and the practice in this country is largely in harmony with this definition, which is adopted by the American Railway Engineering Association.

Outside of the United States a curve is generally designated by its Radius, R. In the United States for railroad purposes, a curve is generally designated by its Degree, D.

40. Problem. *Given R.*
Required D.



$$R \sin \tfrac{1}{2} D = \frac{100}{2}$$

$$\sin \tfrac{1}{2} D = \frac{50}{R} \qquad (1)$$

41. Problem. *Given D.*
Required R.

$$R = \frac{50}{\sin \frac{1}{2} D} \qquad (2)$$

Example. *Given* $D = 1°$.

$R_1 = \dfrac{50}{\sin \frac{1}{2} D}$	50	log	1.698970
	0° 30′	log sin	7.940842
$R_1 = 5729.6$		log	3.758128

42. Problem. *Given* R_1 (radius of 1° curve) or D_1.
Required R_a (radius of any given curve of degree $= D_a$).

$$R_1 = \frac{50}{\sin \frac{1}{2} D_1} \qquad R_a = \frac{50}{\sin \frac{1}{2} D_a}$$

$$\frac{R_a}{R_1} = \frac{\sin \frac{1}{2} D_1}{\sin \frac{1}{2} D_a}. \qquad R_a = R_1 \frac{\sin \frac{1}{2} D_1}{\sin \frac{1}{2} D_a} \qquad (3)$$

In the case of small angles, the angles are proportional to the sines (approximately),

$$R_a = R_1 \frac{\frac{1}{2} D_1}{\frac{1}{2} D_a}; \quad R_a = R_1 \frac{D_1}{D_a} \qquad (3\,A)$$

But $R_1 = 5730$ to nearest foot,

$$R_a = \frac{5730}{D_a} \text{ (approx.)} \qquad (4)$$

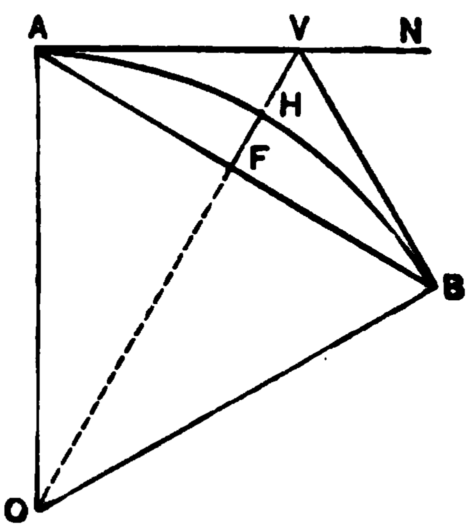
Example. $R_{10} = 573.7$ by (3), or by Allen's Table I.
$= 573.0$ by (4) (approx.)

Some engineers use shorter chords for sharp curves, as 1° to 7°, 100 ft.; 8° to 15°, 50 ft.; 16° to 20°, 25 ft.

Values of R and D are readily convertible. For this purpose, use Table I., Allen [rather than formula (1) or (2)], when accurate results are required. In problems later, where either R or D is given, both will, in general, be assumed to be given. Approximate values can be found without tables by (4). The radius of a 1° curve = 5730 should be remembered. Precise results are, in general, necessary.

43. Problem. *Given I, also R or D.*

Required T.



$$AOB = NVB = I$$

$$AO = OB = R$$

$$AV = VB = T$$

$$T = R \tan \tfrac{1}{2} I \qquad (5)$$

Example. *Given* $D = 9$; $I = 60° 48'$.

Required T_9.

Table I., R_9 log = 2.804327
30° 24′ log tan = 9.768414
$T_9 = 373.9$ log 2.572741

Note that log R_9 is taken directly from Table I.

44. Approximate Method.

$$T_1 = R_1 \tan \tfrac{1}{2} I; \quad T_a = R_a \tan \tfrac{1}{2} I$$

$$\frac{T_a}{T_1} = \frac{R_a}{R_1} = \frac{D_1}{D_a} = \frac{1}{D_a} \text{ (approx.)}$$

$$T_a = \frac{T_1}{D_a} \text{ (approx.)} \qquad (6)$$

Table III., Allen, gives values of T_1 for various values of I.

Table IV., Allen, gives a correction to be added *after* dividing by D_a.

Example. As before. *Given* $D = 9$; $I = 60° 48'$.

Required T_9.

Table III.,	T_1 60° 48′	= 3361.6(9
	T_9	= 373.51 (approx.)
Table IV., correction, 9° and 61°		= .38
	T_9	= 373.9 (exact)
		the same as before

45. Problem. *Given I, also R or D.*

Required E.

Using previous figure, $$\text{VH} = E = R \text{ exsec } \tfrac{1}{2} I \qquad (7)$$

Table XXXIII. shows definition of exsecant.
Table XIX. gives natural exsec.
Table XV. gives logarithmic exsec.
Approximate Method.

By method used for (6), $$E_a = \frac{E_1}{D_a} \text{ (approx.)} \qquad (8)$$

Table V. gives values for E_1.

46. Problem. *Given I, also R or D.*

Required M.

$$\text{FH} = M = R \text{ vers } \tfrac{1}{2} I \qquad (9)$$

Table XXXIII. shows definition of versine.

Table XIX. gives natural vers.
Table XV. gives logarithmic vers.
Table II. gives certain middle ordinates.

47. Problem. *Given I, also R or D.*

Required chord AB = *C.*

$$C = 2 R \sin \tfrac{1}{2} I \qquad (10)$$

Table VIII. gives values for certain long chords.

48. Transposing, we find additional formulas, as follows:

$$\text{from (5)} \quad R = T \cot \tfrac{1}{2} I \tag{11}$$

$$(7) \quad R = \frac{E}{\text{exsec} \tfrac{1}{2} I} \tag{12}$$

$$(9) \quad R = \frac{M}{\text{vers} \tfrac{1}{2} I} \tag{13}$$

$$(10) \quad R = \frac{C}{2 \sin \tfrac{1}{2} I} \tag{14}$$

$$(4) \quad D_a = \frac{5730}{R_a} \text{ (approx.)} \tag{15}$$

$$(6) \quad D_a = \frac{T_1}{T_a} \text{ (approx.)} \tag{16}$$

$$(8) \quad D_a = \frac{E_1}{E_a} \text{ (approx.)} \tag{17}$$

49. Problem. *Given sub-angle d, also R or D.*
Required sub-chord c.

$$c = 2 R \sin \tfrac{1}{2} d \tag{18}$$

Approximate Method.

$$100 = 2 R \sin \tfrac{1}{2} D$$

$$\frac{c}{100} = \frac{\sin \tfrac{1}{2} d}{\sin \tfrac{1}{2} D} = \frac{d}{D} \text{ (approx.)} \tag{19}$$

The precise formula is seldom if ever used.

50. Problem. *Given sub-chord c, also R or D.*
Required sub-angle d.

$$d = \frac{cD}{100} \tag{20}$$

The value $\frac{d}{2}$ is more frequently needed and

$$\frac{d}{2} = \frac{c}{100} \frac{D}{2} \tag{21}$$

A modification of this formula is as follows:

$$\frac{d}{2}=\frac{cD}{200}$$

for $$D=1$$

$$\frac{d}{2}=c\frac{60'}{200}=c\times 0.3'$$

for any value D_a

$$\frac{d}{2}=c\times 0.3'\times D_a \text{ (result in minutes)} \qquad (22)$$

This gives a very simple and rapid method of finding the value of $\frac{d}{2}$ in minutes, and the formula should be remembered.

Example. *Given sub-chord* $=63.7$. $D=6^\circ\,30'$.
Required sub-angle d $\left(\textit{or } \frac{d}{2}\right)$.

I. By (20)

$$\begin{array}{r} 63.7 \\ \underline{6.5} = D \\ 3185 \\ \underline{3822} \\ 414.05 \\ \\ 4^\circ.14 \\ \underline{60'} \\ d = 4^\circ\,08' \end{array}$$

$$\frac{d}{2}=2^\circ\,04'$$

II. By (21)

$$\begin{array}{r} 63.7 \\ \underline{3.25} = \frac{D}{2} \\ 3185 \\ 1274 \\ \underline{1911} \\ 207.025 \\ \\ 2^\circ.07 \\ \underline{60'} \end{array}$$

$$\frac{d}{2}=2^\circ\,04'$$

III. By (22)

$$\begin{array}{r} 63.7 \\ \underline{0.3} \\ 19.11 \\ \underline{6.5} = D \\ 9555 \\ \underline{11466} \\ 124.215 \text{ minutes} \end{array}$$

$$\frac{d}{2}=2^\circ\,04'$$

Method III. is often preferable to I. or II.

51. Problem. *Given I and D.*
Required L.

The "Length of Curve" L is the distance around the curve, measured as stated in § 38, or $L = c_1 + 100\,n + c_2$.

(*a*) When the *P.C.* is at a *full station*, D will be contained in I a certain number of times n, and there will remain a sub-angle d_2 subtended by its chord c_2, and $L = 100\,n + c_2$.

$$\frac{I}{D} = n + \frac{d_2}{D} = \quad n + \frac{c_2}{100} \text{ (approx.)}$$

$$100\frac{I}{D} \quad = 100\,n + c_2 = L \text{ (approx.)}$$

(*b*) When the *P.C.* is at a *sub-station* and *P.T.* at a *full station*, the same reasoning holds, and

$$L = 100\frac{I}{D} \text{ (approx.)}$$

(*c*) When both *P.C.* and *P.T.* are at *sub-stations*, the same formula holds

$$L = 100\frac{I}{D} \text{ (approx.)} \tag{23}$$

Transposing,

$$I = \frac{LD}{100} \text{ (approx.)} \tag{24}$$

$$D = \frac{100\,I}{L} \tag{25}$$

These formulas (23)(24)(25), though approximate, are the formulas in common use.

Example. *Given* 7° *curve.* $I = 39°\,37'$. *Required L.*

$$\begin{array}{ll} I = & 39°\,37 \\ D = 7) & \underline{39.6167°} \\ & 5.6595 + \end{array} \qquad L = 566.0$$

Example. *Given D and L. Required I.*
Given 8° *curve.*

$$\begin{array}{rr} \textit{also, } P.T. = & 93 + 70.1 \\ P.C. = & \underline{86 + 49.3} \\ L = & 7 \quad 20.8 \\ D = & \underline{8} \\ & 57.664 \\ & \underline{60'} \\ & 39.84 \end{array} \qquad I = 57°\,40'$$

52. Field-work of finding *P.C.* and *P.T.*

In running in the line, it is common practice to continue the stationing as far as V, to set a plug and mark a witness stake with the station of V as thus obtained. The angle I is then measured and "repeated" as a "check."

Having given I only, an infinite number of curves could be used. It is, therefore, necessary to assume additional data to determine what curve to use. It is common to proceed as follows:

(*a*) Assume either (1) D directly.
(2) E and calculate D.
(3) T and calculate D.

It is often difficult to determine off-hand what degree of curve will best fit the ground. Frequently the value of E_a can be readily determined on the ground. The determination of D from E_a is readily made, using the approximate formula $D_a = \frac{E_1}{E_a}$. Similarly, we may be limited to a given (or ascertainable) value of T_a, and from this readily find $D_a = \frac{T_1}{T_a}$.

This process is to determine what value of D_a will fit the ground, and it is convenient, generally, to use the degree or half degree nearest to that calculated. (Some engineers use $1° 40' = 100'$ and $3° 20' = 200'$, etc., rather than $1° 30'$ or $3° 30'$, etc.)

When the D_a is thus determined, all computations must be strictly based on this value of D_a.

(*b*) From the data finally adopted T is *calculated anew.*

(*c*) The instrument still being at V, the *P.T.* is set by laying off T. It is economical to set *P.T.* before *P.C.*

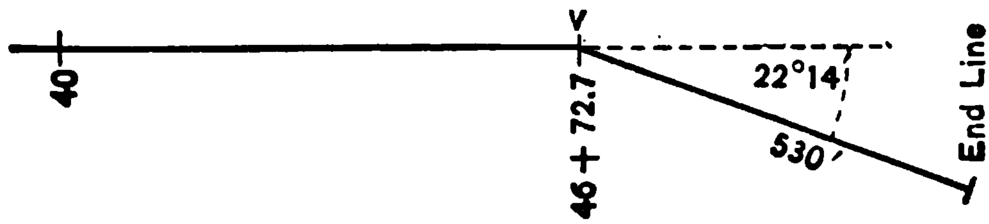
(*d*) The station of *P.C.* is calculated and *P.C.* set from the nearest station stake (or by measuring back from V).

(*e*) The length of curve L is calculated, and station of *P.T.* thus determined (not by adding T to station of V).

Whether D, E, or T shall be assumed depends upon the special requirements in each case. Curves are often run out from *P.C.* without finding or using V, but the best engineering usage seems to be in favor of setting V, whenever this is at all practicable, and from this finding the *P.C.* and *P.T.*

53. Example. *Given a line, as shown in sketch.*
Required a Simple Curve to connect the Tangents.

P.T. is to be at least 300 ft. from end of line.
Use smallest degree or half degree consistent with this.
Find degree of curve and stations of *P.C.* and *P.T.*



		530	
		300	
Table III. 22° 14′		$T_1 = 1125.8$ (230 = T (approx.)	
		92 (4.9 −	use 5° curve
		205	
	$T_1 = 1125.8$ (5°		
	225.16		$V = 46 + 72.7$
Table IV. corr.	.07	$I = 22° 14'$	$T = 2 + 25.2$
	$T = 225.2$	$= 22°.2333$ (5°	$P.C. = 44 + 47.5$
		$L = 444.7$	$L = 4 + 44.7$
			$P.T. = 48 + 92.2$

It will be noticed that the station of the *P.T.* is found by adding *L* to the stations of the *P.C.* (*not* by adding *T* to the station of *V*).

Similarly *Given* $E = 17$ ft.

Table V. 22° 14′		$E_1 = 109.6$ (17 = E	
		102 (6.4 +	use 6° 30′ curve
		76	
	$T_1 = 1125.8$ (6.5		
	173.20	$I = 22°.2333$ (6.5	$V = 46 + 72.7$
corr.	.09	$L = 342.1$	$T = 1 + 73.3$
	$T = 173.3$		$P.C. = 44 + 99.4$
			$L = 3 + 42.1$
			$P.T. = 48 + 41.5$

Under the conditions prescribed above, when *T* is given, the degree, or half degree, next larger must be used, in order to secure *at least* the required distance (to end of line above).

When *E* is given, the nearest half degree is generally used.

54. Method of **Deflection Angles.**

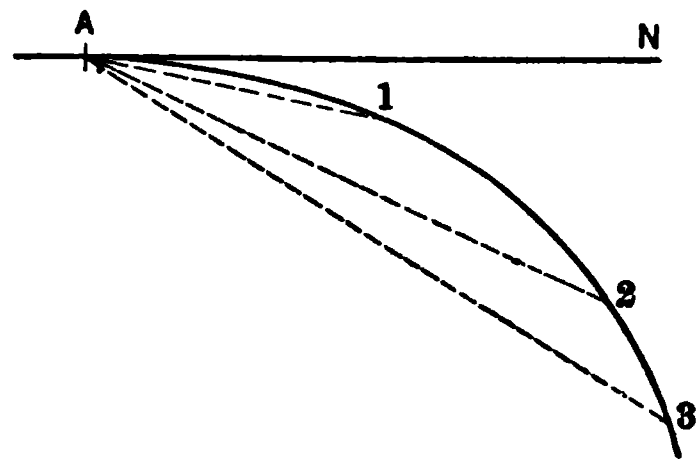
If at any point on an existing curve a tangent to the curve be taken, the angles from the tangent to any given points on the curve may be measured, and the angles thus found may be called **Total Deflections** to those points (as NA1, NA2, NA3).

In laying out successive points upon a straight line (as on a "Tangent"), each point is generally fixed by

(*a*) measurement from the preceding point and

(*b*) line;

the line on a tangent will be the same for all points.



Similarly, in laying out a curve, successive points may be fixed by

(*a*) measurement from the preceding point and

(*b*) line;

the line in this case, for the curve, will be that found by using the *total deflection* calculated for each point. In the figure preceding, the chord distance A1 and the total deflection NA1 fix point 1; the chord distance 1–2 and total deflection NA2 fix point 2; and 2–3 and NA3 fix 3. A curve can be conveniently laid out by this method if the proper total deflections can be readily computed.

55. The method of "Deflection Angles" is well adapted to surveying an existing curve; it is also well adapted to laying out any curve, provided only that it is possible to readily determine

(*a*) the "Total Deflection Angles" and

(*b*) the chord lengths that go with them.

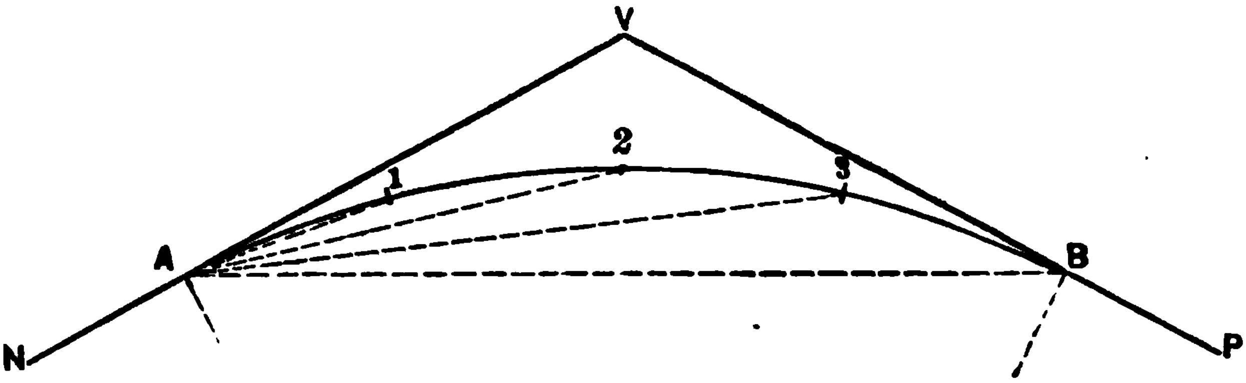
In the case of "*Simple Curves*," the "total deflections" can be readily computed, and the method of "deflection angles" is therefore well adapted to laying them out.

In the case of "spiral" or "transition" curves, tables have commonly been computed, so that the angles and chords are taken from the tables. Any curve which has been surveyed by this method can be restaked on the ground by using the deflection angles and chords measured and recorded.

56. Problem. To find the *Total Deflections* for a Simple Curve having *given* the *Degree.*

I. *When the curve begins and ends at even stations.*

The distance from station to station is 100 feet. The deflection angles are required.



An acute angle between a tangent and a chord is equal to one half the central angle subtended by that chord

$$A1 = 100 \qquad VA1 = \tfrac{1}{2}D$$

The acute angle between two chords having their vertices in the circumference is equal to one half the arc included between those chords.

$$1 - 2 = 100 \text{ and } 1A2 = \tfrac{1}{2}D \quad \text{Similarly,}$$

$$2 - 3 = 100 \text{ and } 2A3 = \tfrac{1}{2}D$$

$$3 - B = 100 \text{ and } 3AB = \tfrac{1}{2}D$$

This angle $\frac{1}{2}D$ is called by Henck and Searles the **Deflection Angle,** and will be so called here. Shunk and Trautwine call it the "*Tangential Angle.*" The weight of engineering opinion appears to be largely in favor of the "Deflection Angle."

The "*Total Deflections*" will be as follows:

$$VA1 = \tfrac{1}{2}D$$

$$VA2 = VA1 + \tfrac{1}{2}D$$

$$VA3 = VA2 + \tfrac{1}{2}D$$

VAB will be found by successive increments of $\frac{1}{2}D$.

VAB = VBA = $\frac{1}{2}I$. This furnishes a "check" on the computation.

II. *When the curve begins and ends with a sub-chord.*

$$VA1 = \tfrac{1}{2}d$$

$$VA2 = VA1 + \tfrac{1}{2}D$$

$$VA3 = VA2 + \tfrac{1}{2}D$$

VAB is found by adding $\frac{1}{2}d_2$ to previous "total deflection."

VAB = VBA = $\frac{1}{2}I$. This furnishes "check." The total deflections should be calculated by successive increments; the final "check" upon $\frac{1}{2}I$ then checks all the intermediate total deflections. The example on next page will illustrate this.

57. Field-work of laying out a simple curve having given the position and station of *P.C.* and *P.T.*

(*a*) Set the transit at *P.C.* (A).

(*b*) Set the vernier at 0.

(*c*) Set cross hairs on V (or on N and reverse).

(*d*) Set off $\frac{1}{2}d_1$(sometimes $\frac{1}{2}D$) for point 1.

(*e*) Measure distance c_1 (sometimes 100) and fix 1.

(*f*) Set off total deflection for point 2.

(*g*) Measure distance 1–2 = 100 and fix 2, etc.

(*h*) When total deflection to B is figured, see that it $= \frac{1}{2}I$, thus "checking" calculations.

(*i*) See that the proper calculated distance c_2 and the total deflection to B agree with the actual measurements on the ground, checking the field-work.

(*k*) Move transit to *P.T.* (B).

(*l*) Turn vernier back to 0, and *beyond* 0 *to* $\frac{1}{2}I$.

(*m*) Sight on A.

(*n*) Turn vernier to 0.

(*o*) Sight towards V (or reverse and sight towards P), and see that the line checks on V or P.

It should be observed that three "checks" on the work are obtained.

1. The calculation of the total deflections is checked if total deflection to B $= \frac{1}{2}I$.

2. The chaining is checked if the final sub-chord measured on the ground = calculated distance.

3. The transit work is checked if the total deflection to B brings the line accurately on B.

The check in 1 is effective only when the total deflection for each point is found by adding the proper angle to that for the preceding point.

The check in 3 assures the general accuracy of the transit work, but does not prevent an error in laying off the total deflection at an intermediate point on the curve.

58. Example. *Given Notes of Curve*

$$\begin{array}{ll} P.T. & 13 + 45.0 \\ P.C. & 10 + 74.0 \end{array} \qquad 6^\circ \text{ curve L}$$

Required the "total deflections"

$$\begin{array}{rrl}
\text{to sta. 11} \quad c_1 = & 26 & \\
 & \underline{.3} & \\
 & 7.8 & \\
 & \underline{6^\circ} & \\
\dfrac{d_1}{2} = & 46.8 & = 0^\circ 47' \text{ to } 11 \\
 & & \underline{3^\circ} \\
c_2 = & 45 & 3^\circ 47' \text{ to } 12 \\
 & \underline{.3} & \underline{3^\circ} \\
 & 13.5 & 6^\circ 47' \text{ to } 13 \\
 & \underline{6^\circ} & \\
\dfrac{d_2}{2} = & 81.0 & = \underline{1^\circ 21'} \\
 & & 8^\circ 08' \text{ to } 13 + 45
\end{array}$$

$$\begin{array}{l}
13 + 45.0 \\
\underline{10 + 74.0} \\
2 \quad 71.0 = L \\
\quad \underline{6^\circ} \\
16.26 \qquad\qquad 16^\circ \\
\quad \underline{60'} \\
15.6' \qquad\qquad \underline{\quad 16'} \\
\qquad\qquad\quad 16^\circ 16' = I \\
\qquad\qquad\quad 8^\circ 08' = \tfrac{1}{2} I \text{ "check"}
\end{array}$$

59. Caution.

If a curve of nearly $180^\circ = I$ is to be laid out from A, it is evident that it would be difficult or impossible to set the last point accurately, as the "intersection" would be bad. It is undesirable to use a total deflection greater than 30°.

It may be impossible to see the entire curve from the *P.C.* at A.

It will, therefore, frequently happen that from one cause or another the entire curve cannot be laid out from the *P.C.*, and it will be necessary to use a modification of the method described above.

60. Field-work. *When the entire curve cannot be laid out from the P. C.*

First Method.

(*a*) Lay out curve as far as C, as before.

(*b*) Set transit point at some convenient point, as C (even station preferably) and move transit to C.

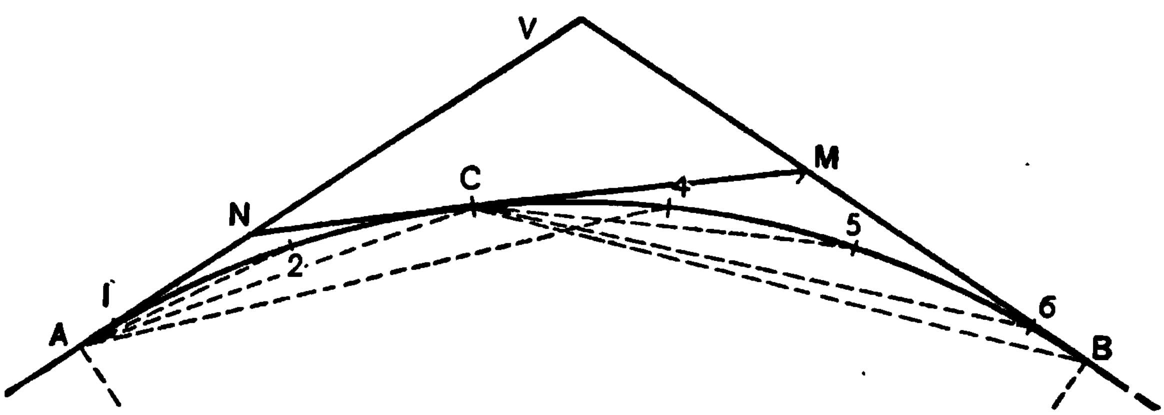
(*c*) Turn vernier back to 0°, *and beyond* 0° by the value of angle VAC.

(*d*) Sight on A.

(*e*) Turn vernier to 0°. See that transit line is on auxiliary tangent NCM (VAC = NCA being measured by $\frac{1}{2}$ arc AC).

(*f*) Set off new deflection angle ($\frac{1}{2}d$ or $\frac{1}{2}D$).

(*g*) Set point 4, and proceed as in ordinary cases.



Second Method.

(*a*) Set point C as before, and move transit to C.

(*b*) Set vernier at 0° and sight on A.

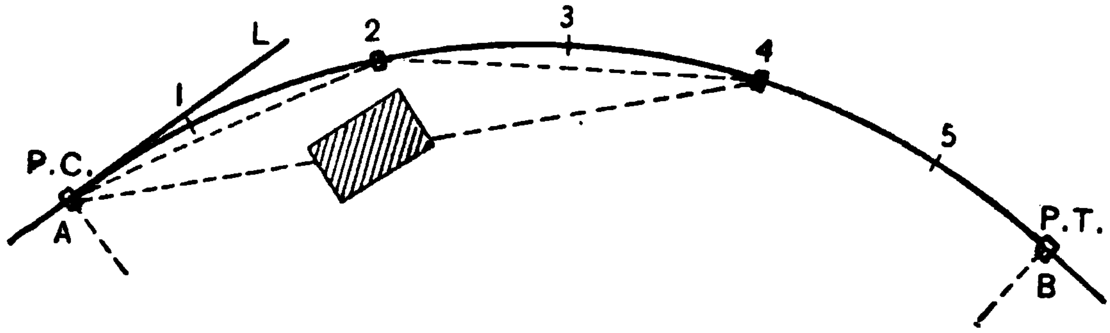
(*c*) Set off the proper "total deflection" for the point 4 = VA 4 NCA + MC 4 = VA 4, each measured by $\frac{1}{2}$ arc AC 4.

(*d*) Reverse transit and set point 4.

(*e*) Set off and use the proper "total deflections" for the remaining points.

The second method is in some respects more simple, as the notes and calculations, and also setting off angles, are the same as if no additional setting were made. By the first method the deflection angles to be laid off will, in general, be even minutes, often degrees or half degrees, and are thus easier to lay off. It is a matter of personal choice which of the two methods shall be used. It will be disastrous to attempt an incorrect combination of parts of the two methods.

61. Field-work. *When the transit is in the curve, and the P.C. is not visible.*



(*a*) Compute deflection angles, *P.C.* to *P.T.*; check on $\frac{I}{2}$ (same as in § 56).

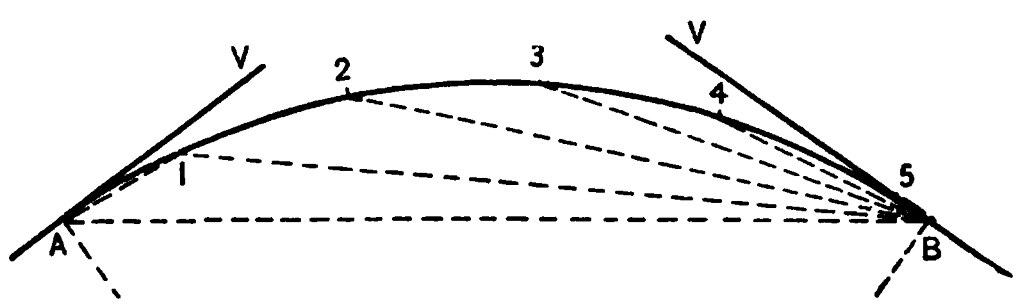
(*b*) Set vernier at deflection angle computed for point (*e.g.* 2) used as backsight.

(*c*) Set line of sight on backsight (2) and clamp.

If vernier be made to read 0°, the line of sight will then be in direction of *P.C.* (since angle L A 2 = 2 4 A).

(*d*) Set off deflection angles computed for 5, etc.

62. Field-work. *When entire curve is visible from P.T.*



(*a*) Compute deflection angles, *P.C.* to *P.T.*; check on $\frac{I}{2}$ (same as in § 56).

(*b*) Set transit at *P.T.* with vernier at 0° and sight on *P.C.*

(*c*) Set off computed angles for 1, 2, 3, 4, 5.

(*d*) Set off $\frac{I}{2}$ and sight at V for check on transit work.

This method is preferable to that given in § 57. It saves the transit setting at *P.C.* The long sights are taken first, before errors of chaining have accumulated and before the transit has settled or warped in the sunlight. The last point on curve is set at a small angle with the tangent, so that the intersection is good and any accumulated errors of chaining will not much affect the line. The method is already accepted practice.

63. Metric Curves.

In Railroad Location under the "**Metric System**" a chain of 100 meters is too long, and a chain of 10 meters is too short. Some engineers have used the 30-meter chain, some the 25-meter chain, but lately the 20-meter chain has been generally adopted as the most satisfactory. Under this system a "*Station*" is 10 meters. Ordinarily, every second station only is set, and these are marked Sta. O, Sta. 2, Sta. 4, etc. On curves, *chords of 20 meters* are used. Usage among engineers varies as to what is meant by the *Degree of Curve* under the metric system. There are two distinct systems used, as shown below.

I. The *Degree of Curve* is the *angle at the center* subtended by a chord of 1 chain of *20 meters.*

II. The *Degree of Curve* is the *deflection angle* for a chord of 1 chain of *20 meters* (or one half the angle at the center).

II. Or, very closely, the *Degree of Curve* is the *angle at the center* subtended by a chord of *10 meters* (equal to 1 station length).

For several reasons the latter system is favored here. Tables upon this basis have been calculated, giving certain data for metric curves. Such tables are to be found in Allen's Field and Office Tables.

In many countries where the metric system is used, it is not customary to use the *Degree of Curve*, as indicated here. In Mexico, where the metric system is adopted as the only legal standard, very many of the railroads have been built by companies incorporated in this country, and under the direction of engineers trained here. The usage indicated above has been the result of these conditions. If the metric system shall in the future become the only legal system in the United States, as now seems possible, one of the systems outlined above will probably prevail.

In foreign countries where the *Degree of Curve* is not used, it is customary, as previously stated, to designate the curve by its radius R, and to use even figures, as a radius of 1000 feet, or 2000 feet, or 1000 meters, or 2000 meters. As the radius is seldom measured on the ground, the only convenience in even figures is in platting, while there is a constantly recurring inconvenience in laying off the angles.

64. Form of Transit Book (left-hand page).

(Date)
(Names of Party)

Station	Points	Descrip. of Curve	Total Deflect.	Observed Course
114				
113				
112				
111				
110				
109	⊙+ 90.0 *P.T.*		11° 15′	N 46° 00′ E
108		$R = 1146.3$	9° 00′	
107	⊙+ 68.0 *V*	$L = 450.0$	6° 30′	
106		$T = 228.0$	4° 00′	
105	⊙+ 40.0 *P.C.*	$I = 22° 30'$ 5° Right	1° 30′	
104				
103				
102				
101				
100				
99				N 23° 15′ E
98				

V is not a point on the curve. Nevertheless, it is customary to record the station found by chaining along the tangent.

The right-hand page is used for survey notes of crossings of fences and various similar data. It seems unnecessary to show a sample here.

65. Circular Arcs. For general railroad work, the Length of Curve is the distance measured by a series of chords as defined in § 38 and § 51. For certain purposes, largely outside of railroad work, the actual length of arc is required. Where the line of a street is curved, the length of the side line of street, the property line of a lot or estate, may be required. Furthermore, both in railroad and street railway work, actual lengths of rails are sometimes required.

Problem. *Given the Central Angle I and Radius R.*
Required the Length of Arc.

Table XX., p. 205, Allen, gives lengths of circular arcs for radius $= 1$. The values for degrees, minutes and seconds are added; the sum multiplied by R is the required length of arc.

Example. *Given* $I = 18° 43' 29''$; $R = 600$.
Required Length of Arc and Deflection Angles.

	18°	0.3141593
	43′	0.0125082
	29″	0.0001406
		0.3268081
	R	600
Length of Arc = 196.08		196.08486

Where a series of points are to be set on the circular arc, there are several methods available, each of which has some desirable features.

I. (*a*) *Divide the entire arc length into an equal number of parts.*

(*b*) Compute the deflection angles to correspond.

(*c*) Compute the chord lengths to correspond.

In the example above, if 4 intermediate points are to be set on the arc, the length of arc will be divided by 5; the final deflection angle will be $\frac{1}{2} I$; and the first deflection angle, i_1, will be $\frac{1}{2} I \div 5$.

$$5 \overline{)196.08} = \text{Length of Arc}$$
$$39.216$$

$$I = 18° \, 43' \, 29''$$
$$\tfrac{1}{2} I = 9° \, 21' \, 44'' \, (5$$
$$i_1 = 1° \, 52' \, 21''$$

The deflection angles will be (to nearest ½ minute) 1° 52′ 30″; 3° 44′ 30″; 5° 37′; 7° 29′ 30″; 9° 21′ 30″. For chaining, the length of chord is necessary and may be computed by formula (10). Where the radius is large, natural sines may not give satisfactory results, and it may be necessary to use the auxiliary tables of log. sines.

A simpler method is to use Allen's Table XX., A, which gives for $R = 1$ the difference between arc and chord for various central angles.

For central angle 3° 45′	diff.	=	0.000012	Table XX., A.
	R	=	600	
			0.007	
	Arc	=	39.216	
	Chord	=	39.209	

The *P.T.* of the circular arc should be set with the required precision by long chord from *P.C.* and the several chords measured with a degree of precision sufficient to secure a "check" against material error.

II. (*a*) *Use a series of equal chords of convenient length, followed by a sub-chord to the P.T.*

(*b*) Compute deflection angles to correspond.

(*c*) Compute chord lengths to correspond.

Example. *Given as before* $I = 18° 43' 29''$; $R = 600$.

Take chord length of 40 ft.

Let $i_1 =$ deflection angle for chord of 40 ft.

Then $\sin i_1 = \dfrac{20}{600}$.

$$i_1 = 1° 54' 37''$$

and $\quad d = 3° 49' 14'' =$ corresponding central angle.

For central angle 3° 49′	diff. =	0.000012	Table XX., A.
	R =	600	
		0.007	
	arc =	40.007	
	4 lengths of arc =	160.028	
	entire arc =	196.085	from p. 37
	sub-arc =	36.057	for $R = 600$
	36.057 ÷ 600 =	0.060095	= sub-arc for $R = 1$

From p. 38,		$0.0600950 = \text{sub-arc for } R = 1$
Table XX.,	3°	0.0523599
		0.0077351
	$26'$	0.0075631
		0.0001720
	$35''$	0.0001697

$$
\begin{aligned}
\text{For central angle } 3^\circ\,27' \text{ diff.} &= 0.000009 \\
R &= \underline{\quad\quad 600} \\
& \quad\; 0.005 \\
\text{sub-arc} &= \underline{36.057} \\
\text{sub-chord} &= 36.052
\end{aligned}
$$

III. (*a*) *Use uniform deflection angles to some convenient even minute, except for final sub-chord.*

(*b*) Compute chord lengths to correspond.

(*c*) Compute arc lengths to correspond.

Example.– *Given as before.* $I = 18^\circ\,43'\,29''$ $R = 600$

For 5 equal arcs $i_1 = 1^\circ\,52'\,21''$

Assume $i_1 = 2^\circ\,00'$; then $2\,i_1 = 4^\circ\,00' = \text{central angle.}$

For central angle 4° $\quad$ diff. $= 0.000014$ Table XX., A.

$$
\begin{aligned}
R &= \underline{\quad\quad 600} \\
& \quad\; 0.008
\end{aligned}
$$

Chord length for $4^\circ = 2 \times 600 \times \sin 2^\circ = \underline{41.880}$

arc length $= 41.888$

$$
\begin{aligned}
& I = 18^\circ\,43'\,29'' \\
4 \times \text{central angle } 4^\circ \quad & = \underline{16^\circ \quad\quad\quad} \\
\text{final sub-angle } d_2 \quad & = \;\; 2^\circ\,43'\,29''
\end{aligned}
$$

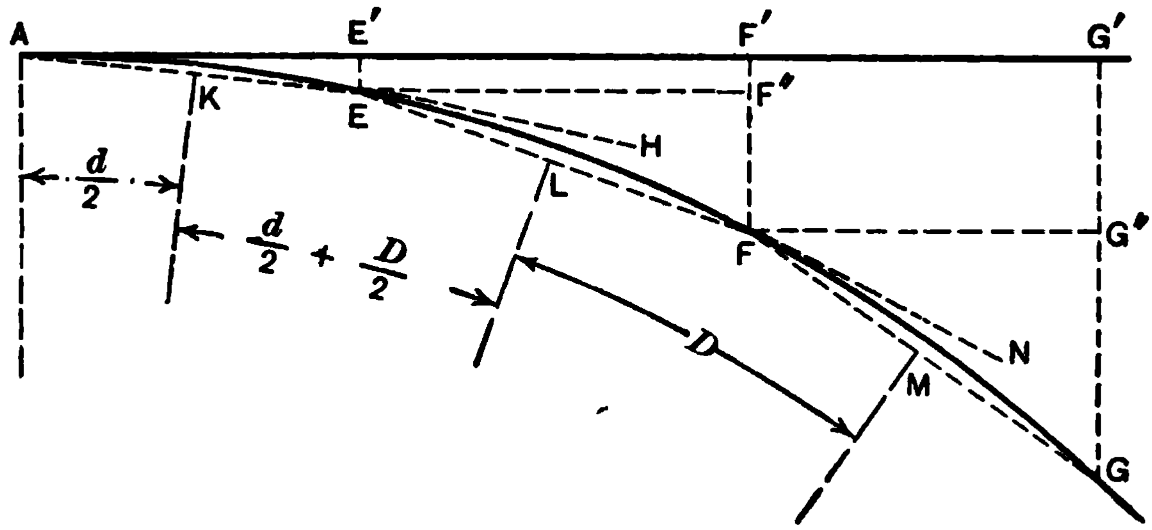
For central angle $2^\circ\,43'$ $\quad$ diff. $= 0.000004$ Table XX., A.

$$
\begin{aligned}
R &= \underline{\quad\quad 600} \\
& \quad\; 0.002
\end{aligned}
$$

For central angle $2^\circ\,43'\,29''$ arc $= 0.0475554$ Table XX.

$$
\begin{aligned}
R &= \underline{\quad\quad\quad 600} \\
& \quad\; 28.53324 \\
\text{diff.} &= \underline{\quad 0.002 \quad} \\
\text{final sub-chord} &= 28.531
\end{aligned}
$$

66. Problem. *Given* D and stations of *P.C.* and *P.T.* *Required* to lay out the curve by the method of **Offsets from the Tangent.**



Let AG′ be tangent to curve AG

Find $E'AE = \frac{1}{2}d \qquad = \alpha_1$

When AE=100, then $\frac{1}{2}d$ becomes $\frac{1}{2}D$.

$F''EF = d + \frac{1}{2}D \qquad = \alpha_2$

$G''FG = d + D + \frac{1}{2}D = \alpha_3$, etc.

Draw EH tangent at E.

Also FN tangent at F.

The α for each chord is found by taking the *central* angle to the *beginning* of the chord plus the *deflection* angle for the chord.

$$\alpha_2 = F''EH + HEF$$
$$= \quad d + \tfrac{1}{2}D$$
$$\alpha_3 = G''FN + NFG$$
$$= d + D + \tfrac{1}{2}D$$

$AE' = c_i \cos \alpha_1 \qquad EE' = c_i \sin \alpha_1$

$EF'' = 100 \cos \alpha_2 \qquad FF'' = 100 \sin \alpha_2$

$FG'' = 100 \cos \alpha_3 \qquad GG'' = 100 \sin \alpha_3$

$FF' = EE' + FF''$

$GG' = FF' + GG''$, etc.

For the computations indicated above, always use natural sines and cosines.

For a check, $\quad AG' = R \sin AOG$

$GG' = R \text{ vers } AOG$

where O is at center of curve.

For the computations immediately above, use log sines and versines.

These "check" computations involve the radius (or degree) and the central angle; the previous computations involve the use of c also; since the formula

$$d = \frac{cD}{100} \tag{20}$$

is an approximate formula, perfect precision in the "check" cannot be expected.

If a "check" perfectly precise is required, use formula (18) $c = 2\,R \sin \frac{1}{2}\,d$ instead of formula (20) and carry all intermediate work to the necessary degree of precision.

This method of Offsets from the Tangent is a precise method, and allows of any desired degree of precision in field-work.

Another method of finding the angles α_1, α_2, α_3, etc., is by drawing perpendiculars to the chords at K, L, and M.

Then
$$\begin{aligned} \alpha_1 &= \tfrac{1}{2}\,d \\ \alpha_2 &= \alpha_1 + \tfrac{1}{2}\,d + \tfrac{1}{2}\,D \\ &= d + \tfrac{1}{2}\,D \text{ (as before)} \\ \alpha_3 &= \alpha_2 + D \text{ etc.} \end{aligned}$$

Each α being found by adding an increment to the previous value of α.

Also
$$\alpha_3 = \text{AOG} - \tfrac{1}{2}\,D$$

which gives a "check" on all values of α computed.

If AE, EF, FG, are parts of a compound curve, the same general methods are applicable, except that the checks of R sin AOG and R vers AOG are not then available.

67. Field-work.

(*a*) Calculate AE′, E′F′, F′G′; also EE′, FF′, GG′

(*b*) Set E′, F′, G′, by measurements AE′, E′F′, F′G′.

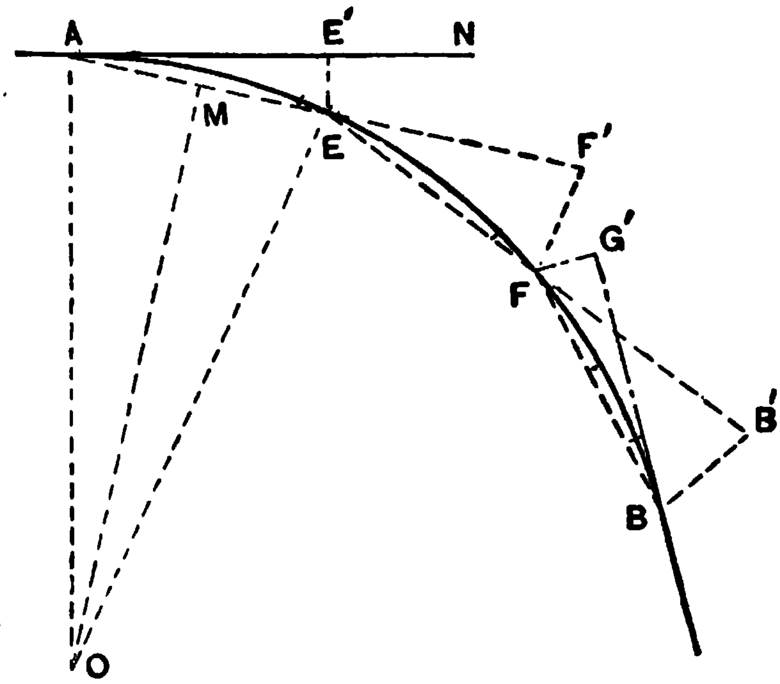
(*c*) Set E by distance AE (c_i) and EE′.

(*d*) Set F " " EF (100) and FF′.

(*e*) Set G " " FG (100) and GG′.

68. Problem. *Given D and the stations of P.C. and P.T. Required to lay out the curve by the method of* **Deflection Distances.**

When the curve begins and ends at even stations.



In the curve AB, let

AN be a tangent

AE any chord $= c$

EE′ perp. to AE′ $= a =$ "tangent deflection"

FF′ = BB′ = the "chord deflection"

AO = EO = R

Draw OM perpendicular to AE.

Then EE′ : AE = ME : EO

$$a : c = \frac{c}{2} : R \qquad \text{or } a = \frac{c^2}{2R} \qquad (26)$$

FF′ $= 2a$; AF′ = AE produced

When AE is a full station of 100 feet, $a_{100} = \dfrac{100^2}{2R}$ (26 A)

Field-work.

The *P.C.* and *P.T.* are assumed to have been set.

(*a*) Calculate a_{100}.

(*b*) Set point E distant 100 ft. from A and distant a_{100} from AE′ (AE′ < 100 ft.; AE′E = 90°).

(*c*) Produce AE to F′ (EF′ = 100 ft.), and find F distant $2a_{100}$ from F′ (EF = 100 ft.).

(*d*) Proceed similarly until B is reached (*P.T.*).

(*e*) At station preceding B (*P.T.*) lay off FG′ $= a_{100}$ (FG′B = 90°).

(*f*) G′B is tangent to the curve at B (*P.T.*).

69. Problem. *Given the degrees of two curves having the same P.C.*

Required the offset between the two curves at the end of a given chord c.

Let D_l and R_l be the D and R of flatter curve, D_s and R_s be the D and R of sharper curve.

For 1° curve $a_1 = \frac{c^2}{2\,R_1}$; $a_l = \frac{c^2}{2\,R_l}$; $a_s = \frac{c^2}{2\,R_s}$

$$\frac{a_l}{a_1} = \frac{\frac{1}{R_l}}{\frac{1}{R_1}} = \frac{D_l}{D_1} \quad \text{(approx.) from (3 A)}$$

$$a_l = a_1 D_l \text{ and } a_s = a_1 D_s. \tag{26 B}$$

Let a_{s-l} = offset between curves $= a_s - a_l$

$$a_{s-l} = a_1 D_s - a_1 D_l$$
$$= a_1(D_s - D_l)\,\text{(approx.)} \tag{27}$$

For 1° curve and $c = 100$ $\quad a_1 = 0.873$ ft. $= \frac{7}{8}$ ft. (nearly).

$$a_{s-l} = \tfrac{7}{8}(D_s - D_l) \text{ ft. (approx.)} \tag{27 A}$$

70. Problem. *Given the offset to any curve for 1 chord of 100 ft.*

Required the offset for any number of chords n, each 100 ft.

$$a = \frac{c^2}{2\,R} \quad \text{and} \quad a_{100} = \frac{100^2}{2\,R} \qquad \text{from (26 A)}$$

for $c = 200$ $\quad a_{200} = \frac{200^2}{2\,R}$; for $c = n\,100$ $\quad a_n = \frac{n^2\,100^2}{2\,R}$

but n chords of 100 ft. each = chord n 100 (nearly) and

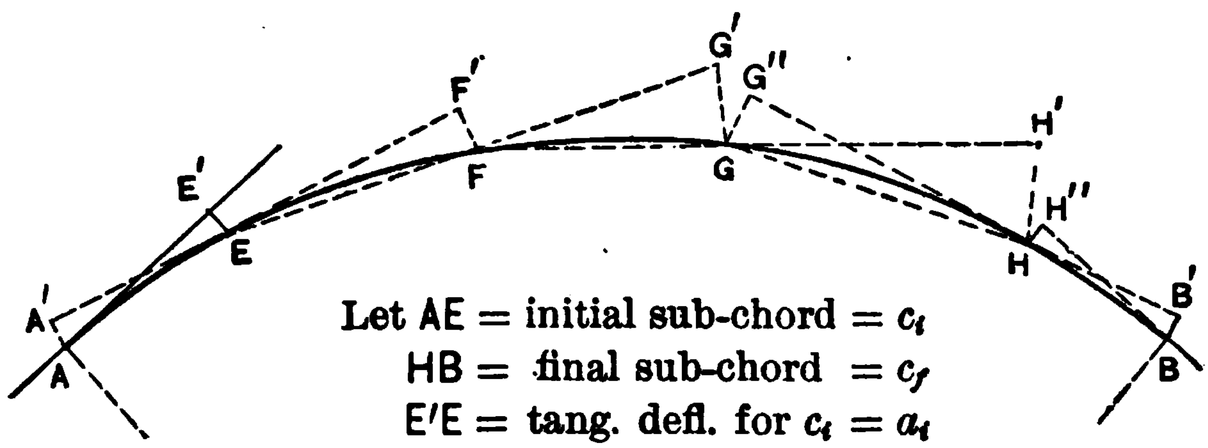
$$a_n = \frac{n^2\,100^2}{2\,R} \quad \text{or} \quad a_n = n^2 a_{100} \quad \text{(approx.)} \tag{28}$$

This approximation may prove too rough for most field-work unless n is very small. It may be of value in plotting. It should seldom be used for other purposes.

Similarly from (27 A) $\quad a_n = \frac{7}{8}(D_s - D_l)n^2$ (roughly).

71. Problem. *Given D and the stations of P.C. and P.T. Required to lay out the Curve by Deflection Distances.*

When the curve begins and ends with a sub-chord.



Let AE = initial sub-chord $= c_i$
HB = final sub-chord $= c_f$
E'E = tang. defl. for $c_i = a_i$
H''H = " " " $c_f = a_f$

by (26) $\qquad a_i = \dfrac{c_i^2}{2R}; \quad a_f = \dfrac{c_f^2}{2R}; \quad a_{100} = \dfrac{100^2}{2R}$

$$\left.\begin{array}{ll} a_i : a_{100} = c_i^2 : 100^2 & a_i = a_{100}\dfrac{c_i^2}{100^2} \\ a_f : a_{100} = c_f^2 : 100^2 & a_f = a_{100}\dfrac{c_f^2}{100^2} \end{array}\right\} \quad (29)$$

In general it is better to use (29) than $a_i = \dfrac{c_i^2}{2R}$.

72. Example. *Given P.T.* $20 + 42$ *P.C.* $16 + 25$ $\quad 6°$ curve R

Required all data necessary to lay out curve by "*Deflection Distances.*"

Calculate without Tables. Result to $\frac{1}{100}$ foot.

Radius 1° curve $= 5730(6$
$\qquad 6° \qquad\qquad 955$

$a_{100} = \dfrac{100^2}{2 \times 955} = 5.24$

$2\,a_{100} = 10.47$

$a_{75} = 0.75^2 \times 5.24 = 2.95$

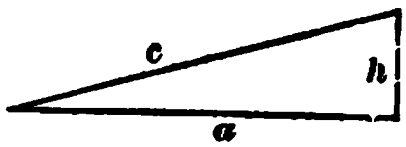
$a_{42} = 0.42^2 \times 5.24 = 0.92$

Table II. gives $a_{100} = 5.234$ (precise value)

```
1910)10000(5.235+
      955
      450
      382
       680
       573
      1070
       955
```

The distance AE′ is slightly shorter than AE. It is generally sufficient to take the point E′ by inspection simply. If desired for this or any other purpose, a simple approximate solution of right triangles is as follows:

73. Problem. *Given the hypotenuse (or base) and altitude. Required the difference between base and hypotenuse,* or in the figure, $c - a$.



$$c^2 - a^2 = h^2$$

$$(c - a)(c + a) = h^2$$

$$c - a = \frac{h^2}{c+a} = \frac{h^2}{2c} \text{ (approx.)} = \frac{h^2}{2a} \text{ (approx.)} \qquad (30)$$

Wherever h is small in comparison with a or c, the approximation is good for ordinary purposes.

Example. $c = 100$ $\qquad c - a = \frac{100}{200} = 0.50$

$h = 10$ $\qquad a = 99.50$

The precise formula gives 99.499.

74. Field-work *for § 71.*

(a) Calculate a_{100}, a_i, a_f. Remember that tangent deflections are as the *squares* of the chords.

a_{100} is found in Table II., Allen, as "tangent offset."

(b) Find the point E, distant a_i from AE′ and distant c_i from A. (AE′E = 90°.)

(c) Erect auxiliary tangent at E (lay off AA′ = a_i).

(d) From auxiliary tangent A′E produced, find point F.

(FF′ = a_{100}; EF = 100; EF′F = 90°).

(e) From chord EF produced, find point G.

(GG′ = 2 a_{100}; FG′ = FG = 100).

(f) Similarly, for each full station, use 2 a_{100}, etc.

(g) At last even station on curve, H, erect an auxiliary tangent (lay off GG″ = a_{100}; GG″H = 90°).

(h) From G″H produced, find B (B′B = a_f, etc.).

(i) Find tangent at B (HH″ = a_f; HH″B = 90°).

The values of a_{100}, a_i, a_f, should be calculated to the nearest $\frac{1}{100}$ foot.

75. Caution. The tangent deflections vary as the *squares* of the chords, not directly as the chords.

Curves may be laid out by this method without a transit by the use of plumb line or "flag" for sighting in points, and with *fair* degree of accuracy.

For calculating a_{100}, a_i, a_f, it is sufficient in most cases to use the approx. value $R_a = \frac{5730}{D_a}$. A curve may be thus laid out without the use of transit or tables.

For many approximate purposes it is well and useful to remember that the "chord deflection" for 1° curve is 1.75 ft. nearly, and for other degrees in direct proportion. A head chainman may thus put himself *nearly* in line without the aid of the transitman.

The method of "Deflection Distances" is not well adapted for common use, but will often be of value in emergencies.

76. Problem. *Given D* and stations of *P.C.* and *P.T.* *Required* to lay out the curve by "*Deflection Distances*" when the *first sub-chord is small.*

Caution. It will not be satisfactory in this case to produce the curve from this short chord. The method to be used can best be shown by example.

Let $PC = 41 + 90$.

Field-work.

Method 1.

(*a*) Set sta. 42 using $c = 10$ and $a_{10} = a_{100}\,\frac{10^2}{100^2}$.

(*b*) Set sta. 43 (100 ft. from 42) offsetting a_{110} from tangent.

(*c*) Set sta. 44 by chord produced and $2\,a_{100}$ offset.

Method 2.

(*a*) Set a point on curve produced backwards, using

$$c = 90 \text{ and } a_{90} = a_{100}\,\frac{90^2}{100^2}.$$

(*b*) Set sta. 42, using $c = 10$ and a_{10} as above.

(*c*) Set sta. 43 by chord produced and $2\,a_{100}$ offset.

A slight approximation is involved in each of these methods. Method 1 involves less labor.

77. Ordinates.

Problem. *Given D and two points on a curve.*

Required the *Middle Ordinate* from the chord joining the two points.

By (9), $M = R \text{ vers } \frac{1}{2} I$

for 100 ft. chord $M = R \text{ vers } \frac{1}{2} D$

between points 2 station lengths apart $M = R \text{ vers } D.$

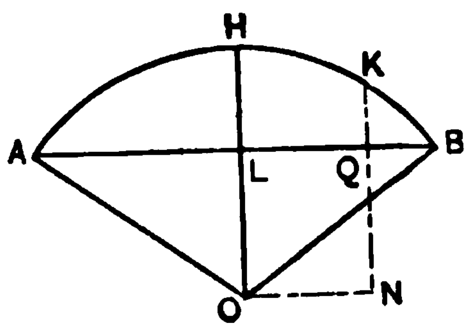
Let A = angle at center between any two points.

$$M = R \text{ vers } \tfrac{1}{2} A.$$

78. Problem. *Given R and c.*

Required M.

$$\text{OL} = \sqrt{R^2 - \left(\frac{c}{2}\right)^2}$$



$$\text{HL} = M = R - \sqrt{R^2 - \left(\frac{c}{2}\right)^2} \qquad (31)$$

$$M = R - \sqrt{\left(R - \frac{c}{2}\right)\left(R + \frac{c}{2}\right)} \qquad (32)$$

Table XXI., Allen, gives squares and square roots for certain numbers. If the numbers to be squared can be found in this table, use (31). Otherwise use logarithms and (32).

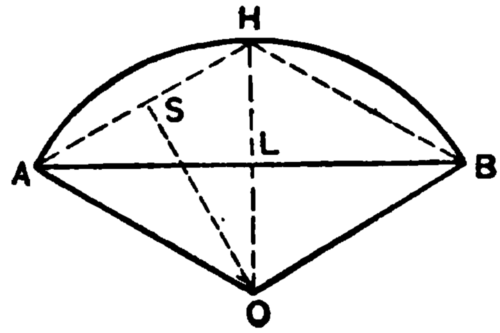
79. Problem. *Given R and C.*

Required the *Ordinate* at any *given point* Q.

Measure LQ $= q$. Then KN $= \sqrt{R^2 - q^2}$

$$\text{LO} = \sqrt{R^2 - \left(\frac{c}{2}\right)^2}$$

$$\text{PQ} = \text{KN} - \text{LO} = \sqrt{(R+q)(R-q)} - \sqrt{\left(R + \frac{c}{2}\right)\left(R - \frac{c}{2}\right)} \qquad (33)$$



80. When $C = 100$ ft. or less, an approximate formula will generally suffice.

Problem. *Given R and c.*
Required M (approx.)

$$HL : AH = \frac{AH}{2} : R$$

$$M = \frac{AH^2}{2R}.$$

Where AB is small compared with R,

$$AH = \frac{c}{2} \text{ (approx.)}$$

$$M = \frac{c^2}{8R} \text{ (approx.)} \qquad (34)$$

81. Example. *Given* $C = 100$, $D = 9°$.
Required M.

$$R_9 = \frac{5730}{9} = 636.7$$

```
           636.7
               8
         -------
         5093.6)10000.(1.963 = M
                 50936
                 ------
                 490640
                 458424
                 ------
                  322160
                  305616
                  ------
                   16544
```

Precise value
$M = 1.965$

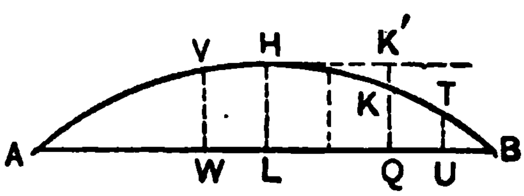
Table XXVII., Allen, gives middle ordinates for curving rails of certain lengths.

82. Problem. *Given R* and c.
Required Ordinate at any given point Q
Approximate Method.

I. Measure $LQ = q$

$$M = HL = \frac{\left(\frac{c}{2}\right)^2}{2R} \text{ (approx.)}$$

$$KK' = \frac{HK^2}{2R}$$



$$KK' : M = HK^2 : \left(\frac{c}{2}\right)^2$$

Since $HK = q$ (approx.) $$KK' = \frac{q^2}{\left(\frac{c}{2}\right)^2} M \text{ (approx.)} \quad (35)$$

$$KQ = M - KK'$$

When $\frac{q}{\frac{c}{2}} = \frac{1}{2}$ as in figure, $KK' = \frac{M}{4}$ and $KQ = \frac{3}{4} M$ (approx.)

When $\frac{q}{\frac{c}{2}} = \frac{1}{4}$ $\qquad VW = \frac{15}{16} M$ (approx.)

When $\frac{q}{\frac{c}{2}} = \frac{3}{4}$ $\qquad TU = \frac{7}{16} M$ (approx.)

The curve thus found is accurately a parabola, but for short distances this practically coincides with a circle.

83. II. *Approximate Method.* Measure LQ and QB

$$M = \frac{\left(\frac{c}{2}\right)^2}{2R} \qquad KK' = \frac{q^2}{2R} \text{ (approx.) from} \quad (26)$$

$$KQ = \frac{\left(\frac{c}{2}\right)^2 - q^2}{2R} = \frac{\left(\frac{c}{2} + q\right)\left(\frac{c}{2} - q\right)}{2R} \text{ (approx.)}$$

$$KQ = \frac{AQ \times QB}{2R} \text{ (approx.)} \quad (36)$$

Sometimes one, sometimes the other of these methods will be preferable.

84. Example. *Given* $C = 100$, $D = 9°$.
$M = 1.965$ from Tables.
Required, Ordinate at point 30 ft. distant from center toward end of chord.

I. 30 ft. $= \frac{30}{50} \times \frac{C}{2}$

$KK' = \frac{9}{25} \times 1.965$

```
           1.965
               9
      25)17.685
          .70740
M =       1.965
Ordinate = 1.258
```

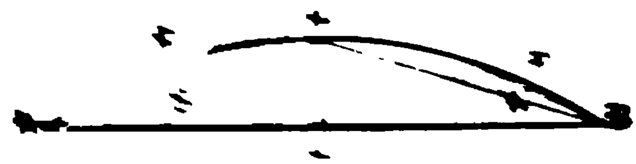
Precise result for data above = 1.260.

II.

```
          AQ =   80
          BQ =   20
       1273.4)1600(1.256
              1273.4
R1 = 5730.     32660
R9 =  636.7    25468
2 R9 = 1273.4   71920
                63670
                 8250
```

53. Problem. Given R and c.

Required a series of points on the curve.



[illegible] $= \frac{c^2}{8R}$ approx.

[illegible] approx. [illegible] approx.)

[illegible] approx.

[illegible] approx., etc., as far as desirable.

This method is useful for many general purposes, for ordinates in bending rails among others.

54. Problem. Given a simple curve ending in a tangent. Required the [illegible] a new curve of the same [illegible] which shall end in a parallel tangent.

Let AB be the given curve

AB' [illegible] required curve

BB' [illegible] perpendicular distance between tangents.

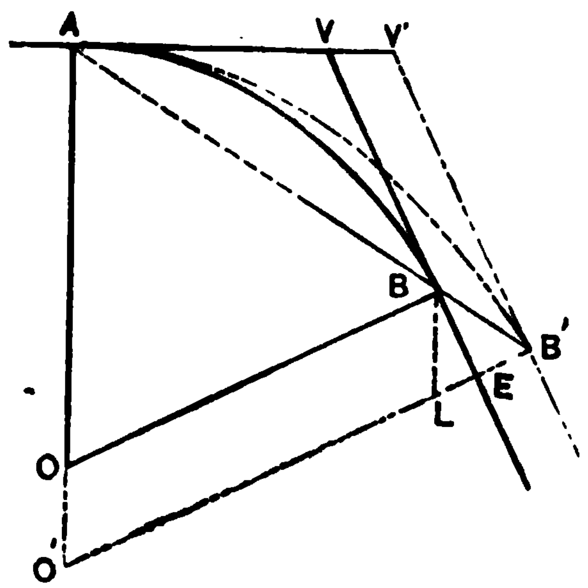
Join [illegible]

[illegible]

[illegible]

[illegible] be transformed.

87. Problem. *Given a Simple Curve joining two tangents. Required* the *Radius* of a new curve which with the *same P.C.* shall end in a *parallel tangent.*



Let AB be the given curve of radius $R = \text{AO}$.

$\text{B}'\text{E} = p =$ perpendicular distance.

AB′ the required curve, radius $= R'$.

Draw chords AB, AB′;

also line BB′;

also BL parallel to AO.

Then
$$\text{BLB}' = \text{AO}'\text{B}' = I$$
$$\text{BL} = \text{OO}'$$
$$= R' - R$$
$$= \text{B}'\text{L}$$

Therefore
$$\text{BL vers BLB}' = \text{B}'\text{E}$$
$$(R' - R) \text{ vers } I = p$$
$$(R' - R) = \frac{p}{\text{vers } I} \qquad (38)$$

Since $\text{VAB} = \text{V}'\text{AB}'$, AB and AB′ are in the same straight line.

And with transit at A, point B′ can be set by measuring BB′ in direction AB.

Also
$$\text{BB}' = \frac{\text{B}'\text{E}}{\sin \text{B}'\text{BE}} \quad \text{or } \text{BB}' = \frac{p}{\sin \frac{1}{2} I} \qquad (39)$$

When the proposed tangent is *outside* the original tangent (as it is shown in the figure), the above formula applies, and

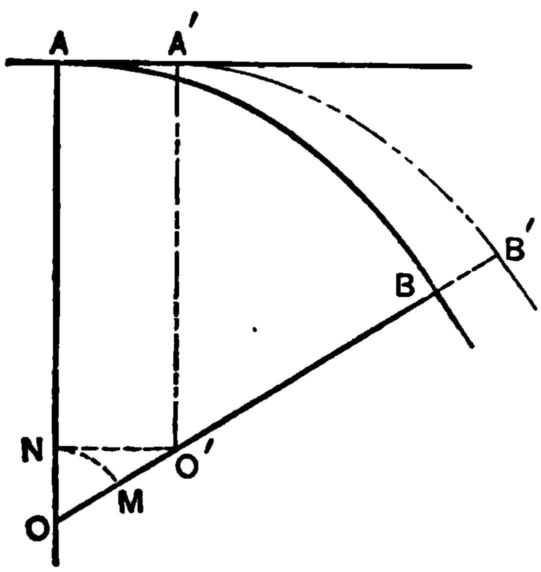
$$R' > R.$$

When the proposed tangent is *inside* the original tangent, the formula becomes

$$R - R' = \frac{p}{\text{vers } I} \qquad (40)$$

and $R' < R$.

88. Problem. *Given a Simple Curve joining two tangents. Required the radius and P.C. of a new curve to end in a parallel tangent with the new P.T. directly opposite the old P.T.*



Let AB be the given curve of radius $= R$.

A'B' the required curve of radius R'.

$\text{BB}' = p$.

Draw perpendicular O'N and arc NM.

Then $\text{O'M} = \text{B'M} - \text{B'O'}$

$= \text{B'M} - \text{BM} = \text{BB}'$

$\text{O'M} = p$

$$\text{ON} \quad \text{exsec NOO}' = \text{O'M}$$

$$(R - R') \text{ exsec } I \quad = p; \qquad R - R' = \frac{p}{\text{exsec } I} \tag{41}$$

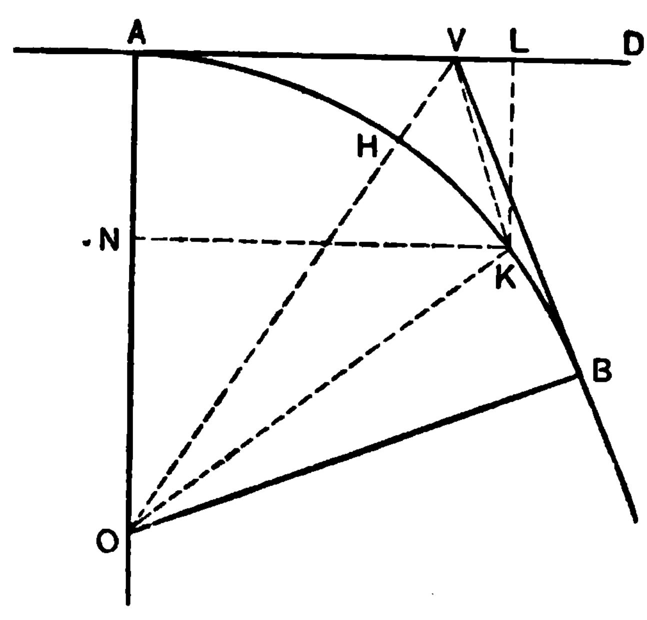
$$\text{AA}' = \text{O'N} = \text{ON} \tan \text{NOO}'$$

$$\text{AA}' = (R - R') \tan \quad I \tag{42}$$

When the new tangent is *outside* the original tangent (as in the figure), $R > R'$ and AA' is added to the station of the *P.C.*

When the new tangent is *inside* the original tangent, $R < R'$, $R' - R = \dfrac{p}{\text{exsec } I}$, and AA' is subtracted from station of *P.C.*

89. Problem. *To find the Simple Curve that shall join two given tangents and pass through a given point.*



With the transit at V, the given point K can often be best fixed by angle BVK and distance VK. If the point K be fixed by other measurements, these generally can readily be reduced to the angle BVK and distance VK.

90. Problem. *Given the two tangents intersecting at V, the angle I, and the point K fixed by angle BVK = β and distance VK = b.*
Required the radius R of curve to join the two tangents and pass through K.

In the triangle VOK we have given

$$\mathsf{VK} = b \text{ and } \mathsf{OVK} = \frac{180 - I}{2} - \beta$$

Further $$\mathsf{VO} = \frac{R}{\cos \frac{1}{2} I} \qquad \mathsf{OK} = R$$

$$\mathsf{VO} : \mathsf{OK} = \sin \mathsf{VKO} : \sin \mathsf{OVK}$$

$$\frac{R}{\cos \frac{1}{2} I} : R = \sin \mathsf{VKO} : \cos(\tfrac{1}{2} I + \beta)$$

$$\sin \mathsf{VKO} = \frac{\cos(\frac{1}{2} I + \beta)}{\cos \frac{1}{2} I} \tag{43}$$

From data thus found, the triangle VOK may be solved for *R*. In solving this triangle the angle VOK is often very small. A slight error in the value of this small angle may occasion a large error in the value of *R*. In this case use the following **Second Method** of finding *R* after VOK has been found.

Find $\mathsf{AOK} = \frac{1}{2} I + \mathsf{VOK}$ Also $\mathsf{DVK} = I + \beta$

Then
$$R \text{ vers } \mathsf{AOK} = \mathsf{LK}$$
$$= b \sin \mathsf{DVK}$$
$$R = \frac{b \sin \mathsf{DVK}}{\text{vers } \mathsf{AOK}} \tag{44}$$

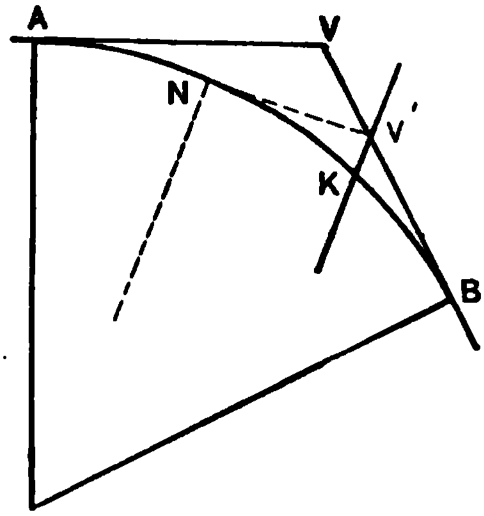
91. Problem. *Given R, I, β (BVK).*
Required b (VK).

In the triangle VOK

$$\mathsf{OK} = R; \quad \mathsf{OV} = \frac{R}{\cos \frac{1}{2} I}$$

$$\mathsf{OVK} = 90 - (\tfrac{1}{2} I + \beta)$$

Solve triangle for *b*.
Also find VOK and station of K if desired.



92. Problem. *To find the point where a straight line intersects a curve between stations.*

Find where the straight line V′K cuts VB at V′.

Measure KV′B.

Use V′ as an auxiliary vertex.

Find *I*′ from V′B by (5).

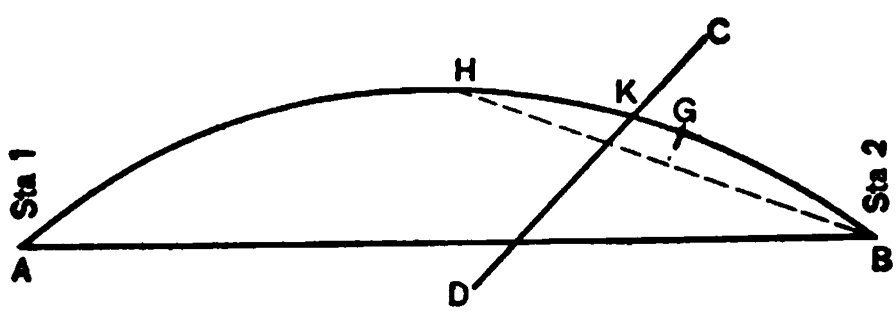
Solve by preceding problem.

93. Approximate Method.

Set the middle point H by method of ordinates.

If the arc HB is sensibly a straight line, find the intersection of HB and CD.

Otherwise set the point G by method of ordinates, and get intersection of HG and CD.

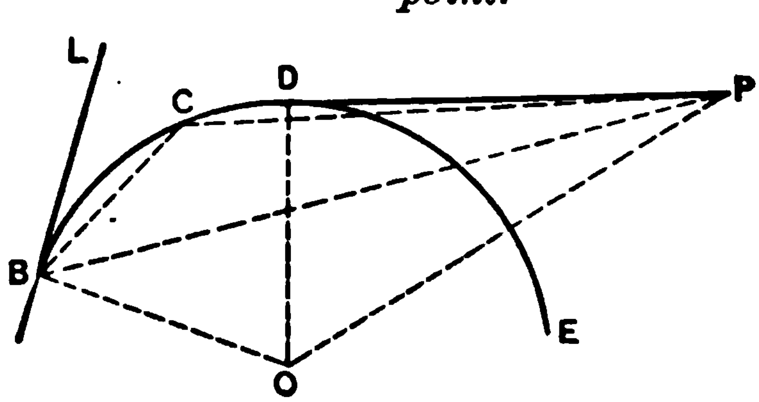


Additional points on the arc may be set if necessary, and the process continued until the required precision is secured.

The points H and G can be set without the use of a transit with sufficient accuracy for many purposes, a plumb line or flag being used in "sighting in."

94. Problem. *Given a Simple Curve and a point outside the curve.*

Required a tangent to the curve from that point.



Let BDE be the given curve.

P the point outside the curve.

BL a tangent at B.

Measure LBP, also BP.

In the triangle BPO we have given PBO, BP, BO.

Solve the triangle for BOP and OP.

Then
$$\cos \text{DOP} = \frac{\text{OD}}{\text{OP}} = \frac{R}{\text{OP}}$$

$$\text{BOD} = \text{BOP} - \text{DOP}$$

From BOD find station of D from known point B.

It should be noted that if *log* OP is found, this can be used again without looking out the number for OP. Other similar cases will occur elsewhere in calculation.

When for any reason it is difficult or inconvenient to measure BP directly, the angles CBP, BCP and the distance BC may be measured and BP calculated.

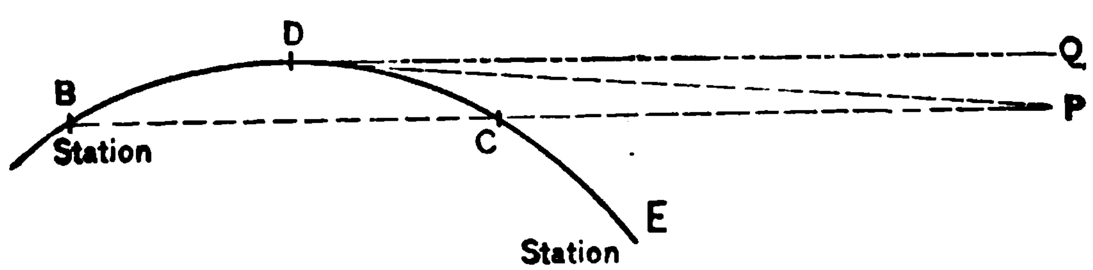
94 A. Tentative Method.

Field-work.

(*a*) From the station (B) nearest to the required point D, find by the approximate method where BP cuts the curve at C. (If E be the nearest station, produce PC to B.)

(*b*) Assume D with BD slightly greater than CD, and with transit at *P. C.* set the point D (transit point) truly on the curve.

(*c*) Move the transit to D, and lay off a tangent to the curve at D. This will very nearly strike P.

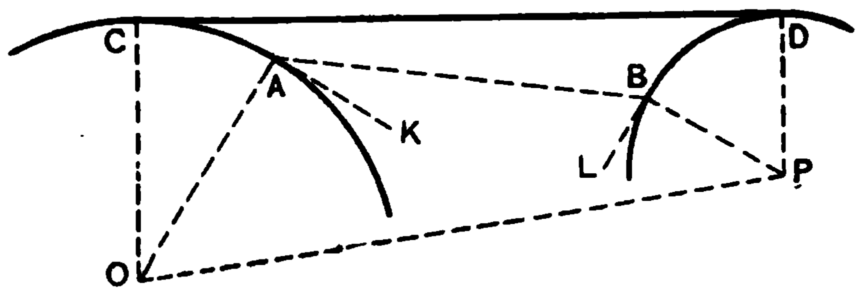


(*d*) If the tangent strikes away from P, at Q, measure QDP, and move the point D (ahead or back as the case may be) a distance *c* due to an angle at the center $d =$ QDP. The tangent from this new point ought to strike P almost exactly.

In a large number of cases the point D will be found on the first attempt sufficiently close for the required purpose.

If a tangent between two curves is required, similar methods by approximation will be found available.

95. Problem. *Given two Simple Curves.*
Required a tangent to both Curves.



Find convenient points A and B on the given curves.

Let AK and BL be tangents.

Measure line AB and angles BAK and ABL.

Let AO = R_l and BP = R_s (both given).

Solve ABPO for line OP and angles AOP and BPO.

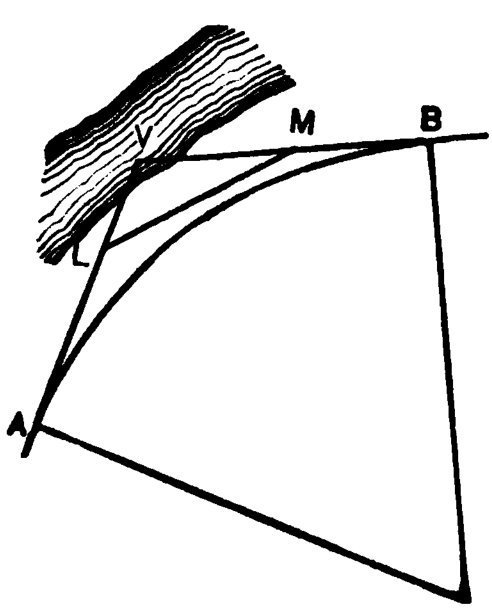
Then, $\cos \text{COP} = \dfrac{R_l - R_s}{\text{OP}}$ and $\text{DPO} = 180° - \text{COP}$.

$$\text{AOC} = \text{COP} - \text{AOP}; \qquad \text{BPD} = \text{DPO} - \text{BPO}.$$

When a tangent is to connect two tracks already laid, it may be determined by a process similar to **94 A** by tentative method.

Obstacles on Curves.

96. When *V* is inaccessible.



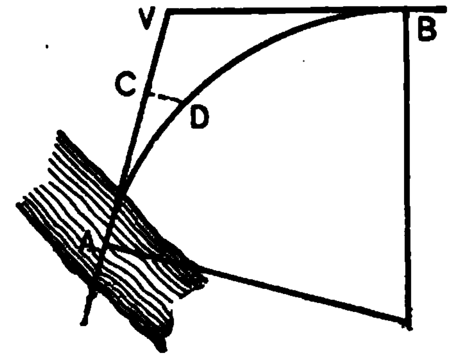
Measure VLM, VML, LM.

$$I = \text{VLM} + \text{VML}$$

LV and VM are readily calculated, and AL and MB determined.

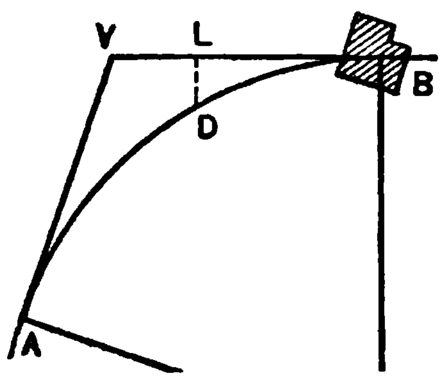
In some cases the best way is to assume the position of *P.C.* and run out the curve as a trial line, and finally find the position of *P.C.* correctly by the method of formula (37).

97. When the *P.C.* is inaccessible.



Establish some point D (an even station is preferable) by method of "offsets from Tangent" or otherwise. Move transit to B (*P.T.*) and run out curve starting from D and checking on tangent VB.

98. When the *P.T.* is inaccessible.



With instrument still at *V*, set some convenient point D, move transit to *P.C.*, and run in curve to D, and then pass the obstacle at B as any obstacle on a tangent would be passed.

99. When **Obstacles on the Curve** occur so as to prevent running in the curve, no general rules can well be given. Sometimes *resetting* the transit in the curve will serve. Sometimes, if one or two points only are invisible from the transit, these can be set by "*deflection distances*," and the curve continued by "*deflection angles*," without resetting the transit. Sometimes "*offsets from the tangent*" can be used to advantage. Sometimes points can be set by "*ordinates*" from chords. Sometimes the method shown on page 54, § 92, assuming an auxiliary *V*, is the only one possible.

It should be borne in mind that it is seldom *necessary* that the *full stations* should be set. If it be possible to set any points whose stations are known and which are not too far apart, this is generally sufficient.

Finally, for passing obstacles and for solving many problems which occasionally occur, it is necessary to understand the various methods of laying out curves, and to be familiar with the mathematics of curves; and, in addition, to exercise a reasonable amount of ingenuity in the application of the knowledge possessed.

CHAPTER V.

COMPOUND CURVES.

100. When one curve follows another, the two curves having a common tangent at the point of junction, and lying upon the same side of the common tangent, the two curves form a *Compound Curve.*

When two such curves lie upon opposite sides of the common tangent, the two curves then form a *Reversed Curve.*

In a compound curve, the point at the common tangent where the two curves join, is called the *P.C.C.*, meaning the "point of compound curvature."

In a reversed curve, the point where the curves join is called the *P.R.C.*, meaning the "point of reversed curvature."

Field-work.

Laying out a compound curve or a reversed curve.

(*a*) Set up transit at *P.C.*

(*b*) Run in simple curve to *P.C.C.* or *P.R.C.*

(*c*) Move transit to *P.C.C.* or *P.R.C.*

(*d*) Set line of sight on common tangent with vernier at 0° by method of § 60.

(*e*) Run out second curve as a simple curve.

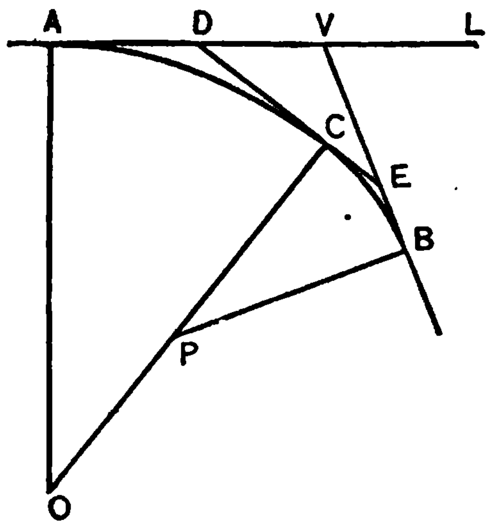
Data Used in Compound Curve Formulas.

In the curve of larger radius, OA $= R_l$; AOC $= I_l$; AV $= T_l$.

In the curve of shorter radius, PB $= R_s$; BPC $= I_s$; VB $= T_s$;

Also LVB $= I$.

101. Problem. *Given R_l, R_s, I_l, I_s.*
Required I, T_l, T_s.



Draw the common tangent DCE.

Then $\quad I = I_l + I_s$

$$AD = CD = R_l \tan \tfrac{1}{2} I_l$$

$$EB = CE = R_s \tan \tfrac{1}{2} I_s$$

or find CD and CE, using Allen's Table III. and the correction, Table IV.

In the triangle DVE we have one side and three angles

$$DE = R_l \tan \tfrac{1}{2} I_l + R_s \tan \tfrac{1}{2} I_s \qquad (45)$$

$$VDE = I_l\,;\ VED = I_s\,;\ \text{and}\ DVE = 180 - I$$

Solve for VD and VE $\qquad$ then $\quad AV = AD + VD = T_l$

$$VB = BE + VE = T_s$$

102. Problem. *Given T_s, R_s, I_s, I.*
Required T_l, R_l, I_l.

$$I_l = I - I_s.$$

Find $\quad$ CE = EB from D_s and I_s (Tables III. and IV.)

Having given VE and all three angles

Solve for DE and DV; also find CD.

Then $\quad T_l = AV = CD + DV$

Also $\quad R_l = \dfrac{CD}{\tan \frac{1}{2} I_l}$

103. Problem. *Given T_l, R_l, I_l, I.*
Required T_s, R_s, I_s.

$$I_s = I - I_l.$$

Find $\quad$ AD = DC from D_l and I_l (Tables III. and IV.)

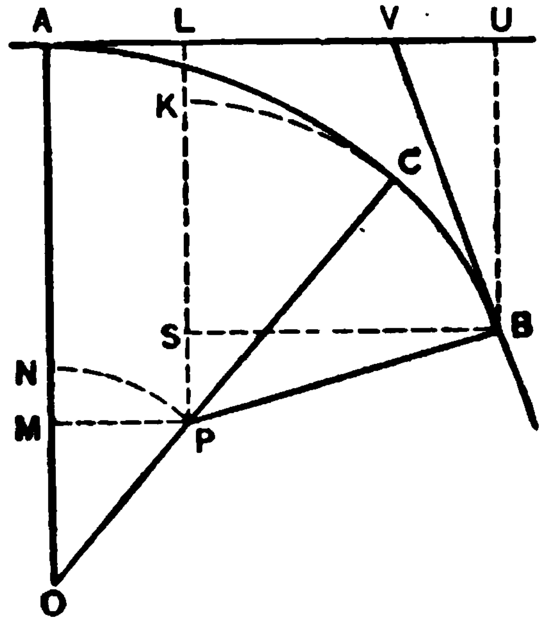
Having given DV and all three angles

Solve for DE and VE; also find CE.

Then $\quad T_s = VB = VE + CE$; and $R_s = \dfrac{CE}{\tan \frac{1}{2} I_s}$

See § 105 and § 108 for other solutions of § 102 and § 103.

104. Problem. *Given* T_s, R_s, R_l, I.
Required T_l, I_l, I_s.



Draw arcs NP and KC.

Draw perpendiculars MP, LP, SB, UB.

Then

$$AM = LP$$

$$AN = R_s = KP$$

$$NM = LK = LS - KS$$

$$OP \text{ vers } NOP = VB \sin VBS - PB \text{ vers } KPB$$

$$(R_l - R_s) \text{ vers } I_l = T_s \sin I - R_s \text{ vers } I$$

$$\text{vers } I_l = \frac{T_s \sin I - R_s \text{ vers } I}{R_l - R_s} \tag{46}$$

$$I_s = I - I_l$$

$$AV = MP + SB - UV$$

$$T_l = (R_l - R_s) \sin I_l + R_s \sin I - T_s \cos I \tag{47}$$

105. Problem. *Given* T_s, R_s, I_s, I.
Required T_l, R_l, I_l.

$$I_l = I - I_s$$

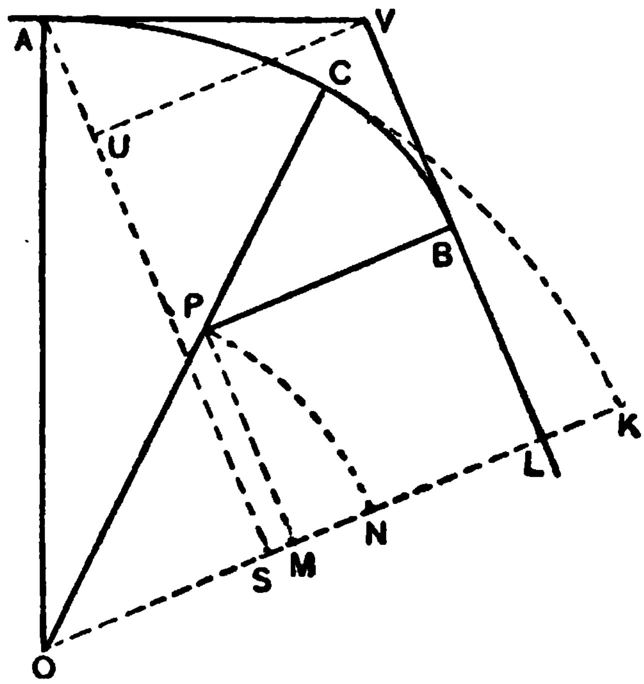
$$R_l - R_s = \frac{T_s \sin I - R_s \text{ vers } I}{\text{vers } I_l} \tag{48}$$

$$T_l = (R_l - R_s) \sin I_l + R_s \sin I - T_s \cos I \tag{49}$$

106. Problem. *Given* T_l, T_s, R_s, I.
Required R_l, I_l, I_s.

$$\tan \tfrac{1}{2} I_l = \frac{T_s \sin I - R_s \text{ vers } I}{T_l + T_s \cos I - R_s \sin I} \tag{50}$$

$$R_l - R_s = \frac{T_l + T_s \cos I - R_s \sin I}{\sin I_l} \tag{51}$$



107. Problem.

Given T_l, R_l, R_s, I.

Required T_s, I_l, I_s.

Draw arcs NP, KC.

Draw perpendiculars OK, AS, PM, VU.

Then $LM = BP$
$= KN$

$MN = LM - LN$
$= KN - LN$
$= KL$

$$LK = MN = \quad KS \quad - \quad LS$$

$$OP \text{ vers } NOP = AO \text{ vers } AOK - AV \sin VAS$$

$$(R_l - R_s) \text{ vers } I_s = R_l \text{ vers } I - T_l \sin I$$

$$\text{vers } I_s = \frac{R_l \text{ vers } I - T_l \sin I}{R_l - R_s} \tag{52}$$

$$I_l = I - I_s$$

$$VB = \quad AS \quad - \quad PM \quad - \quad AU$$

$$T_s = R_l \sin I - (R_l - R_s) \sin I_s - T_l \cos I \tag{53}$$

108. Problem. *Given* T_l, R_l, I_l, I.
Required T_s, R_s, I_s.

$$I_s = I - I_l$$

$$R_l - R_s = \frac{R_l \text{ vers } I - T_l \sin I}{\text{vers } I_s} \tag{54}$$

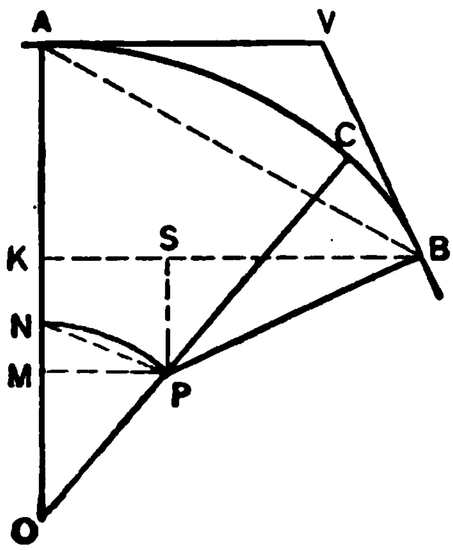
$$T_s = R_l \sin I - (R_l - R_s) \sin I_s - T_l \cos I \tag{55}$$

109. Problem. *Given* T_l, T_s, R_l, I.
Required R_s, I_l, I_s.

$$\tan \tfrac{1}{2} I_s = \frac{R_l \text{ vers } I - T_l \sin I}{R_l \sin I - T_l \cos I - T_s} \tag{56}$$

$$R_l - R_s = \frac{R_l \sin I - T_l \cos I - T_s}{\sin I_s} \tag{57}$$

110. Problem. *Given, in the figure,* AB, VAB, VBA, R_s.
Required R_l, I_l, I_s, I.



Draw arc NP; also perpendiculars KB, MP, SP.

$$I = \text{VAB} + \text{VBA}$$

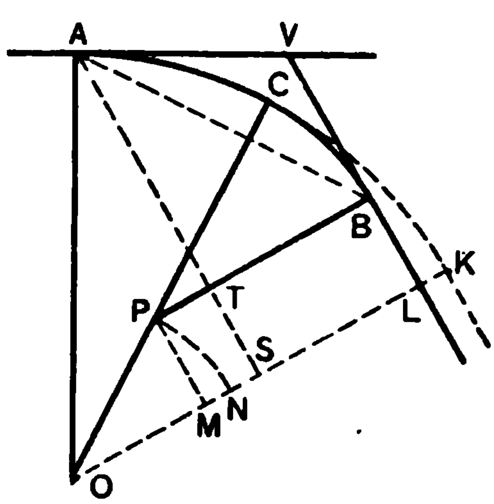
$$\begin{aligned}
\text{NM} &= \text{AK} + \text{KM} - \text{AN} \\
&= \text{AB} \sin \text{VAB} + \text{PB} \cos \text{SPB} - \text{AN} \\
&= \text{AB} \sin \text{VAB} + R_s \cos I - R_s \\
&= \text{AB} \sin \text{VAB} - R_s \text{ vers } I \\
\text{MP} &= \text{KB} - \text{SB} \\
&= \text{AB} \cos \text{VAB} - \text{PB} \sin \text{SPB} \\
&= \text{AB} \cos \text{VAB} - R_s \sin I
\end{aligned}$$

$$\tan \text{NPM} = \tan \tfrac{1}{2} I_l = \frac{\text{NM}}{\text{MP}} \tag{58}$$

$$I_s = I - I_l$$

$$\text{OP} = R_l - R_s = \frac{\text{MP}}{\sin I_l} \tag{59}$$

111. Problem. *Given, in the figure,* AB, VAB, VBA, R_l.
Required R_s, I_l, I_s, I.



Draw arc PN; also perpendiculars PM, AS.

$$I = \text{VAB} + \text{VBA}$$

$$\begin{aligned}
\text{NM} = \text{LK} &= \text{SK} - \text{SL} \\
&= \text{OA vers AOK} - \text{AB} \sin \text{VBA} \\
&= R_l \text{ vers } I - \text{AB} \sin \text{VBA} \\
\text{MP} &= \text{AS} - \text{AT} \\
&= \text{OA} \sin \text{AOK} - \text{AB} \cos \text{VBA} \\
&= R_l \sin I - \text{AB} \cos \text{VBA}
\end{aligned}$$

$$\tan \text{NPM} = \frac{\text{NM}}{\text{MP}} \tag{60}$$

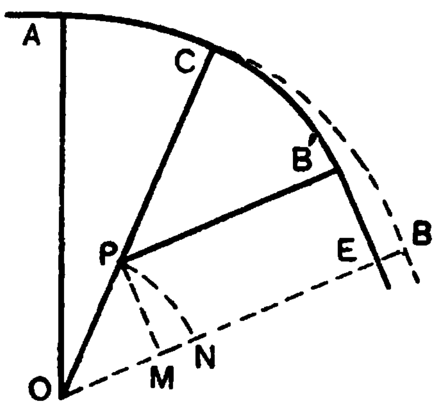
$$\tan \tfrac{1}{2} I_s = \frac{\text{NM}}{\text{MP}}$$

$$I_l = I - I_s \tag{61}$$

$$\text{OP} = R_l - R_s = \frac{\text{MP}}{\sin I_s}$$

112. Problem. *Given a Simple Curve ending in a given tangent.*

A second curve of given radius is to leave this and end in a given parallel tangent.



Required the P.C.C.

Let AB be the given curve of radius R_l.

C be the $P.C.C.$

CB′ the second curve of radius R_s.

BE $=p=$ distance between tangents.

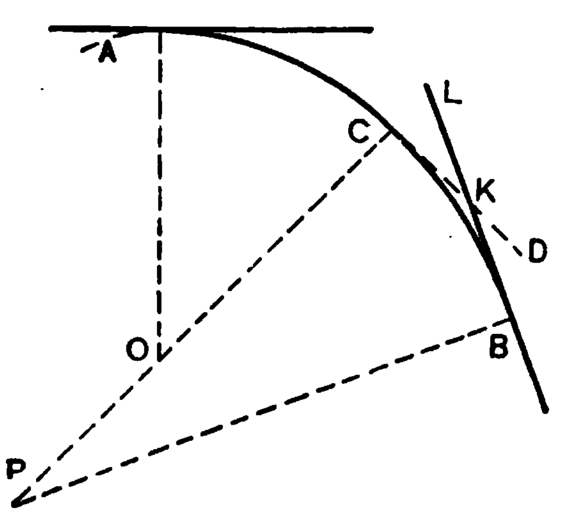
Then MN $=$ EB $=p$.

$$\text{vers COB} = \frac{\text{MN}}{\text{OP}}$$

$$\text{vers COB} = \frac{p}{R_l - R_s} \qquad (62)$$

113. *Given, a Simple Curve of radius R_1; also a line not tangent to this curve.*

Required, the radius R_2 of a second curve to connect a given point on this curve as a P.C.C., with the given line as a tangent.



Let AC be the given curve of radius R_1.

LB the given line.

C be a point selected (as convenient or necessary) as the given $P.C.C.$

CB the required curve of radius R_2.

From C lay off auxiliary tangent CD cutting LB at K.

Measure CK and angle DKB

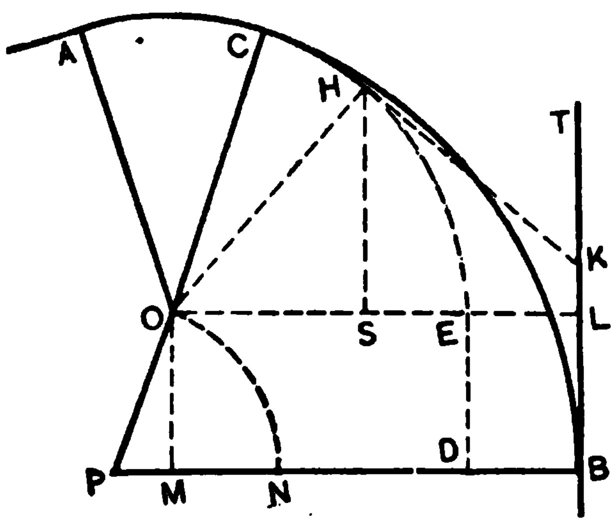
$$\text{Then } R_2 = \frac{\text{CK}}{\tan \frac{1}{2}\,\text{DKB}} \qquad (63)$$

$$\text{KB} = \text{CK}$$

This fixes the position of B, the *P.T.*, thus allowing a "check" on the field-work.

114. ***Given a Simple Curve of radius R_1; also a line not tangent to this curve.***

Required, the P.C.C. of a second curve of given radius R_2 to leave this curve and join the given line as a tangent.



Let ACHE be the given curve.

TB the given line.

AO radius R_1.

PC radius R_2.

CB required second curve.

C required *P.C.C.*

From a convenient point H on the given curve lay off auxiliary tangent HK cutting TB at K.

Measure HK and angle TKH.

Then $\quad \text{HOL} = \text{TKH}$

$$\text{LE} = \text{SL} - \text{SE}$$

$$= \text{HK} \sin \text{TKH} - \text{OH vers HOL}$$

$$p = \text{HK} \sin \text{TKH} - R_1 \text{ vers TKH}$$

Also $\quad \text{DB} = \text{MB} - \text{MD}$

$$\text{MN} = \text{MB} - \text{NB} = \text{DB} = p$$

$$\text{MN} = \text{PO vers OPN}$$

$$\frac{p}{(R_2 - R_1)} = \text{vers } I_2 \tag{64}$$

The angle AOH is given.

$$\text{CPB} - \text{TKH} = \text{COH}$$

$$\text{AOH} - \text{COH} = \text{AOC} = I_1$$

This serves to fix station of *P.C.C.* at C.

Also $\quad \text{KB} = \text{KL} + \text{LB}$

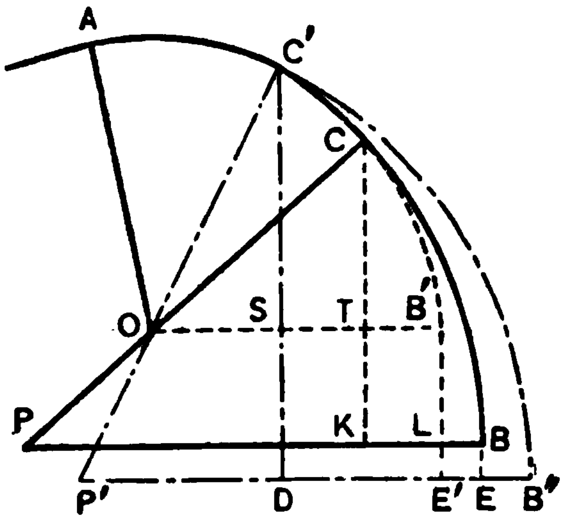
$$= \text{HS} - \text{HK} \cos \text{TKH} + \text{LB}$$

$$= \text{OH} \sin \text{TKH} - \text{HK} \cos \text{TKH} + \text{OP} \sin \text{OPN}$$

$$\text{KB} = R_1 \sin \text{TKH} - \text{HK} \cos \text{TKH} + (R_2 - R_1) \sin I_2$$

115. Problem. *Given a Compound Curve ending in a given tangent.*

Required to change the P.C.C. so as to end in a given parallel tangent, the radii remaining unchanged.



I. When the *new tangent* lies *outside* the *old tangent*, and the *curve ends* with curve of *larger radius*.

Let ACB be the given compound curve.

AC'B'' the required curve.

Produce C'O to P', draw arc C'B'' and connect P'B''.

Produce arc AC to B' and connect OB'.

Draw perpendiculars C'SD, CTK, B'LE', and BE.

Then EB'' = E'B'' − LB

= DB'' − SB' − (KB − TB')

= P'C' vers C'P'B'' − OC' vers C'OB'

− (PC vers CPB − OC vers COB')

$$p = (R_l - R_s) \text{ vers } I_l' - (R_l - R_s) \text{ vers } I_l$$

$$\frac{p}{R_l - R_s} = \text{vers } I_l' - \text{vers } I_l. \qquad (65)$$

116. II. When the *new tangent* lies *inside* the *old tangent*, and the *curve ends* with the curve of *larger radius*.

$$\frac{p}{R_l - R_s} = \text{vers } I_l - \text{vers } I_l'. \qquad (66)$$

117. III. When the *new tangent* lies *outside* the *old tangent*, and the *curve ends* with curve of *smaller radius*.

With a new figure it may be shown that

$$\frac{p}{R_l - R_s} = \text{vers } I_s - \text{vers } I_s' \qquad (67)$$

118. IV. When the *new tangent* lies *inside* the *old tangent*, and the *curve ends* with curve of *smaller radius*.

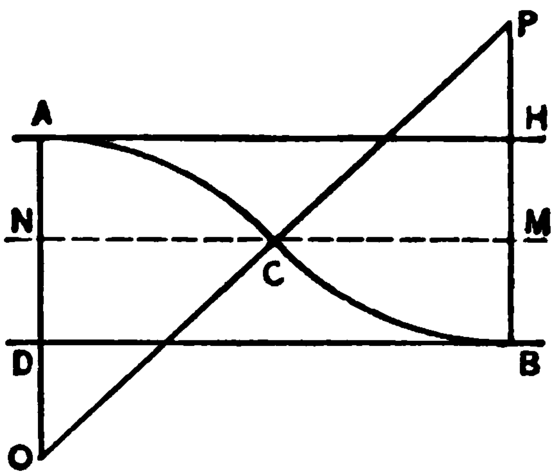
$$\frac{p}{R_l - R_s} = \text{vers } I_s' - \text{vers } I_s \qquad (68)$$

CHAPTER VI.

REVERSED CURVES.

It is considered undesirable that reversed curves should be used on main lines, or where trains are to be run at any considerable speed. The marked change in direction is objectionable, and an especial difficulty results from there being no opportunity to elevate the outer rail at the *P.R.C.* The use of reversed curves on lines of railroad is therefore very generally condemned by engineers. For yards and stations, reversed curves may often be used to advantage, also for street railways, and perhaps for other purposes.

119. Problem. *Given the perpendicular distance between parallel tangents, and the common radius of the reversed curve.*
Required the central angle of each curve.



Let AH and BD be the parallel tangents.

ACB the reversed curve.

HB $= p =$ perpendicular distance between tangents.

Draw perpendicular NM.

Let AOC $=$ BPC $= I_r$.

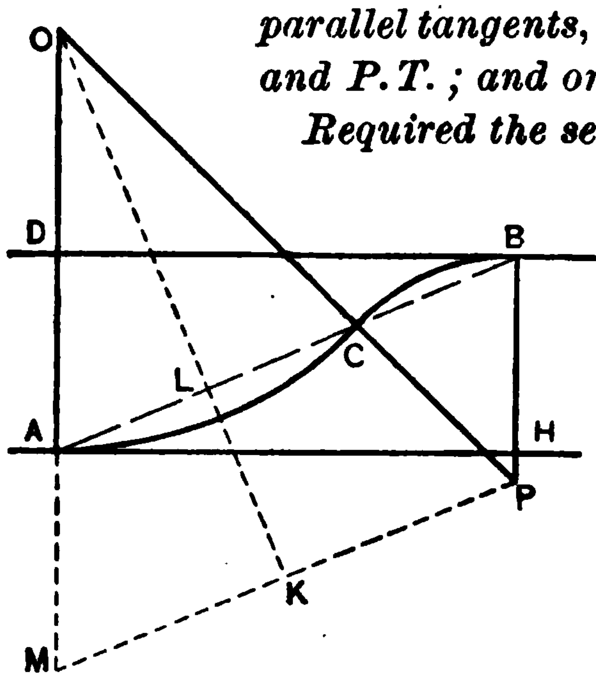
Then
$$\text{vers AOC} = \frac{\text{AN}}{\text{AO}} = \frac{\text{BM}}{\text{PB}} = \frac{\frac{1}{2}\text{HB}}{\text{AO}}$$

$$\text{vers } I_r = \frac{\frac{1}{2}p}{R} \qquad (69)$$

120. Problem. *Given p, I_r.*
Required R.

$$R = \frac{\frac{1}{2}p}{\text{vers } I_r} \qquad (70)$$

121. Problem. *Given the perpendicular distance p between parallel tangents, the chord distance d between P.C. and P.T.; and one radius R_1 of a reversed curve. Required the second radius R_2.*



Let ACB = reversed curve.
AH, DB parallel tangents.

$AB = d \qquad BH = p$

$OA = R_1$ and $PB = R_2$

Connect AC and CB.

AOC = BPC and ACO = PCB

ACB is a straight line.

Draw MP parallel to AB, OK perpendicular to MP.

MP = AB and AM = BP

OM : MK = AB : BH

$$R_1 + R_2 : \tfrac{1}{2} d = d : p \qquad \text{or } R_1 + R_2 = \frac{d^2}{2p} \qquad (71)$$

$$\text{When } R_1 = R_2 = R \qquad R = \frac{d^2}{4p} \qquad (72)$$

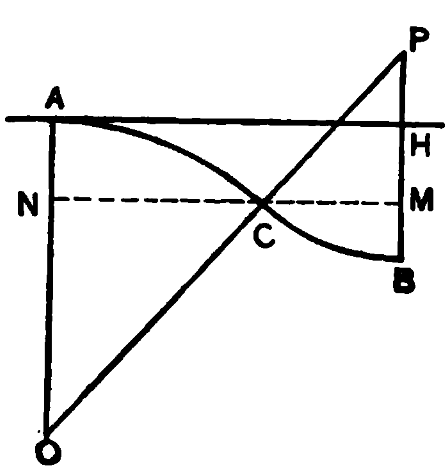
122. Problem. *Given R and p. Required d.*

$$\text{From (71)} \qquad d = \sqrt{2(R_1 + R_2)p} \qquad (73)$$

$$\text{When } R_1 = R_2 = R \qquad d = \sqrt{4Rp} = 2\sqrt{Rp} \qquad (74)$$

123. Problem. *Given the perpendicular distance between two parallel tangents, and the central angle and radius of first curve of reversed curve.*

Required the radius of second curve.



Let ACB = reversed curve

$HB = p$; $AO = R_1$; $PB = R_2$

$AOC = CPB = I_r$

Draw perpendicular NCM.

HB = AN + MB

= AO vers AOC + BP vers BPC

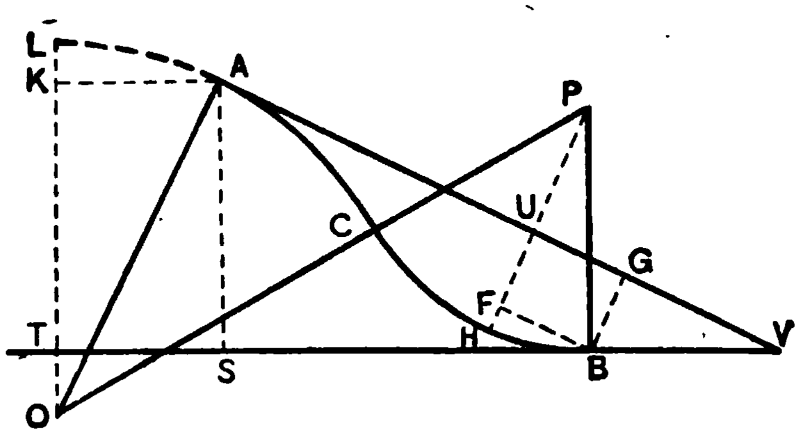
$p = R_1 \text{ vers } I_r + R_2 \text{ vers } I_r$

$$R_1 + R_2 = \frac{p}{\text{vers } I_r} \qquad (75)$$

124. Problem. *Given R_1, R_2, p.*
Required I_r.

from (75) $$\text{vers } I_r = \frac{p}{R_1 + R_2} \tag{76}$$

125. Problem. *Given a P.C. upon one of two tangents not parallel, also the tangent distance from P.C. to V, also the angle of intersection, also the unequal radii of a reversed curve to connect the tangents.*
Required the central angles of the simple curves, and tangent distance, V to P.T.



Let AV $= T_1 =$ given tangent distance
ACB $=$ required curve
AOC $= I_1$ } required angles
BPC $= I_2$ }
BV $= T_2 =$ required tangent distance

A $=$ given *P.C.*
V $=$ vertex
AVT $= I$
AO $= R_1$ } given radii
PB $= R_2$ }
VT $=$ second tangent

Draw arc AL, also perpendiculars OL, AS, AK.

Then LT $= p =$ perpendicular distance between parallel tangents and by (75) $p = (R_1 + R_2)$ vers LOC

$$\text{LT} = \text{LK} + \text{AS}$$
$$(R_1 + R_2) \text{ vers LOC} = \text{AO vers AOL} + \text{AV sin AVS}$$
$$(R_1 + R_2) \text{ vers } I_2 = R_1 \text{ vers } I + T_1 \sin I$$
$$\text{vers } I_2 = \frac{R_1 \text{ vers } I + T_1 \sin I}{R_1 + R_2} \tag{77}$$
$$I_1 = I_2 - I$$

$$\text{BV} = \text{VS} + \text{AK} - \text{TB}$$
$$T_2 = T_1 \cos I + R_1 \sin I - (R_1 + R_2) \sin I_2 \tag{78}$$

126. Problem. *Given* BV *instead of* AV, *and other data as above.*
Required I_1, I_2, *etc.*

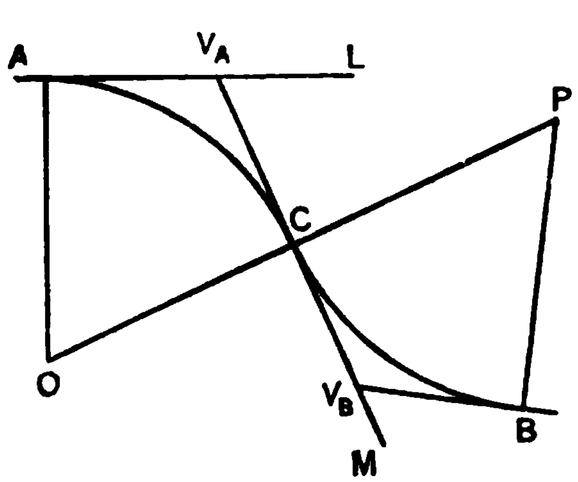
Draw perpendiculars PH, BF, BG.
$\mathrm{UH} = p =$ perpendicular distance between parallel tangents.

$$\mathrm{UH} = \mathrm{FH} + \mathrm{GB}$$
$$(R_1 + R_2) \text{ vers } I_1 = R_2 \text{ vers } I + T_2 \sin I$$
$$\text{vers } I_1 = \frac{R_2 \text{ vers } I + T_2 \sin I}{R_1 + R_2} \qquad (79)$$

$$T_1 = T_2 \cos I + R_2 \sin I + (R_1 + R_2) \sin I_1 \qquad (80)$$

Many problems in reversed curves can be simply and quickly solved by using the available data in a way to bring the problem into a shape where it becomes a case of parallel tangents with p known, and which can be solved by (75).
This is true particularly of sidings and yard problems.

127. Problem. *Given the length of the common tangent and the angles of intersection with the separated tangents.*
Required the common radius of a reversed curve to join the two separated tangents.

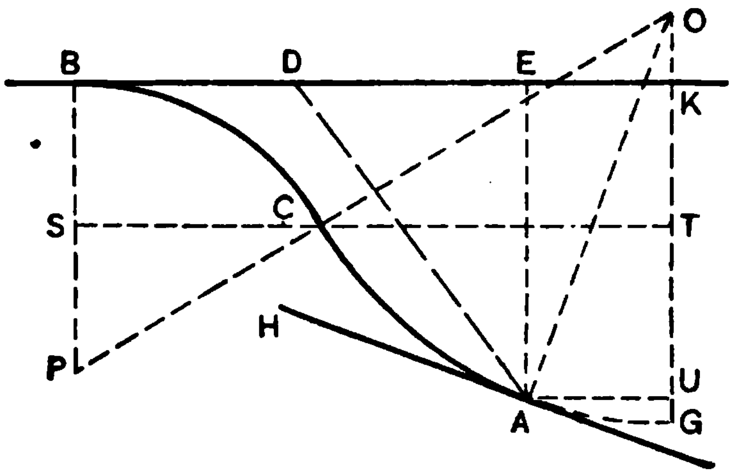


Let $\mathrm{V_AV_B}$ = common tangent
$\mathrm{AV_A}$, $\mathrm{BV_B}$ = separated tangents
ACB = required curve
$\mathrm{LV_AC} = I_A$; $\mathrm{MV_BB} = I_B$
$\mathrm{V_AV_B} = l$

$$\mathrm{V_AV_B} = \mathrm{V_AC} + \mathrm{V_BC}$$
$$l = R \tan \tfrac{1}{2} I_A + R \tan \tfrac{1}{2} I_B$$
$$R = \frac{l}{\tan \frac{1}{2} I_A + \tan \frac{1}{2} I_B} \qquad (81)$$

An approximate method is as follows: —
Find T_{A1} for a 1° curve; also T_{B1} (Table III.)

Then $$D_a = \frac{T_{A1} + T_{B1}}{\mathrm{V_AV_B}} \qquad \text{(approx.)}$$



128. *Given, for a reversed curve, the P.C. lying on a given tangent; also the position of another tangent not parallel; also the unequal radii, R_1 and R_2 of the reversed curve.*

Required the central angles I_1 and I_2; also I; also the position of P.T.

Let ACB be the reversed curve
AH, BK, the given tangents
A, the given *P.C.*
$AOC = I_1$
$CPB = I_2$

Measure from A to some convenient point D on BK; let $AD = b$.
Measure also HAD and ADK.
Then the angle between tangents $= ADK - HAD = I$.
Extend arc CA to G where curve is parallel to BK.
Draw perpendiculars AE, OG, AU, SCT.

$$\begin{aligned} \text{Then}\quad KG &= AE + UG \\ &= AD \sin ADK + OA \operatorname{vers} AOG \\ p &= b \sin ADK + R_1 \operatorname{vers} I \end{aligned}$$

From (76) $\dfrac{p}{R_1+R_2} = \operatorname{vers} I_2$

$$I_1 = I_2 - I$$

$$\begin{aligned} \text{Also } BD &= BK - EK - ED \\ &= ST - AU - ED \\ &= OP \sin CPB - OA \sin AOG - AD \cos ADK \\ &= (R_1 + R_2) \sin I_2 - R_1 \sin I - b \cos ADK \end{aligned}$$

CHAPTER VII.

PARABOLIC CURVES.

129. Instead of circular arcs to join two tangents, parabolic arcs have been proposed and used, in order to do away with the sudden changes in direction which occur where a circular curve leaves or joins a tangent. Parabolic curves have, however, failed to meet with favor for railroad curves for several reasons.

1. Parabolic curves are less readily laid out by instrument than are circular curves.

2. It is not easy to compute at any given point the radius of curvature for a parabolic curve ; it may be necessary to do this either for curving rails or for determining the proper elevation for the outer rail.

3. The use of the "Spiral," or other "Easement," or "Transition" curves secures the desired result in a more satisfactory way.

There are however many cases (in Landscape Gardening or elsewhere) where a parabolic curve may be useful either because it is more graceful or because, without instrument, it is more easily laid out, or for some other reason.

It is seldom that parabolic curves would be laid out by instrument.

130. Properties of the Parabola.

(*a*) The locus of the middle points of a system of parallel chords of a parabola is a straight line parallel to the axis of the parabola (*i.e.* a diameter).

(*b*) The locus of the intersection of pairs of tangents is in the diameter.

(*c*) The tangent to the parabola at the vertex of the diameter is parallel to the chord bisected by this diameter.

(*d*) Diameters are parallel to the axis.

(*e*) The equation of the parabola, the coördinates measured upon the diameter and the tangent at the end of the diameter is

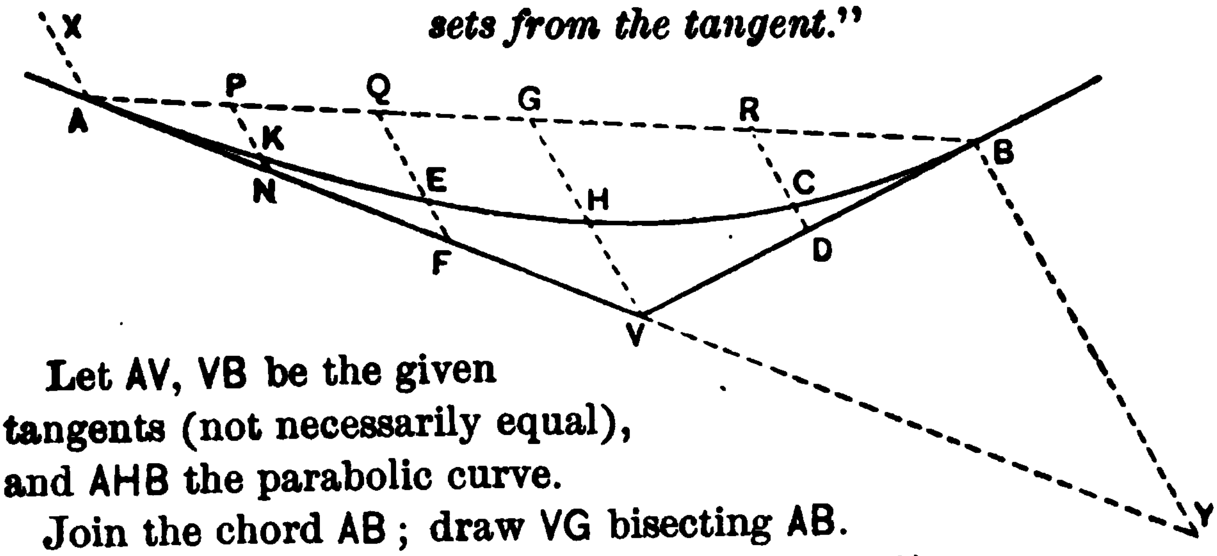
$$y'^2 = \frac{4\,p}{\sin^2\theta}x'$$

or

$$y^2 = 4\,p'x \tag{82}$$

131. Problem. *Given two tangents to a parabola, also the position of P.C. and P.T.*

Required to lay out the parabola by "offsets from the tangent."



Let AV, VB be the given tangents (not necessarily equal), and AHB the parabolic curve.

Join the chord AB; draw VG bisecting AB.

Draw AX, BY, parallel to VG; produce AV to Y.

Then VG is a diameter of the parabola.

AX parallel to VG is also a diameter.

The equation of the parabola referred to AX and AY as axes is

$$y^2 = 4\,p'x.$$

Instead of solving this equation engineers commonly use the proportion

$$y_1^2 : y_2^2 = x_1 : x_2 \tag{83}$$

Hence

$$\begin{aligned} AV^2 : \quad AY^2 &\doteq HV : BY \\ AV^2 : (2\,AV)^2 &= HV : 2\,GV \\ 1 \quad : \quad 4 \quad &= HV : 2\,GV \end{aligned}$$

$$HV = \frac{GV}{2} \tag{84}$$

Next bisect VB at D.

Draw CD parallel to AX.

Then

$$BD^2 : BV^2 = CD : HV$$

$$CD = \frac{HV}{4}$$

Similarly, make $\quad AN = NF = FV$

Then $\quad KN = \frac{HV}{9}$

$$EF = \frac{4}{9}HV$$

In a similar way, as many points as are needed may be found.

132. Field-work.

(*a*) Find G bisecting AB.

(*b*) Find H bisecting GV.

(*c*) Find points P, Q, and N, F, dividing AG, AV, proportionately; also R and D, dividing GB and BV proportionately.
Use simple ratios when possible (as $\frac{1}{2}$, $\frac{1}{3}$, etc.).

(*d*) Lay off on PN, the calculated distance KN

on QF lay off EF

on RD lay off CD

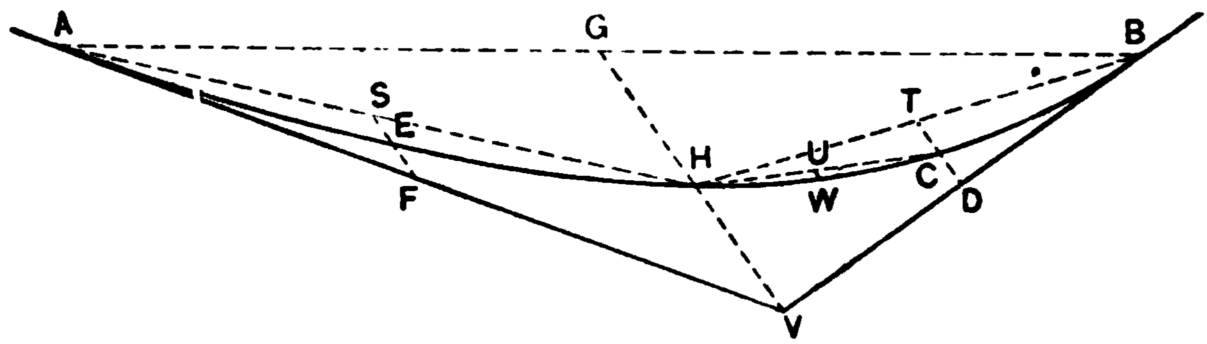
In figure opposite, $\quad KN = \frac{HV}{9}$

$$CD = \frac{HV}{4}$$

$$EF = \frac{4}{9}HV$$

For many purposes, or in many cases, it will give results sufficiently close, to proceed without establishing P, Q, R; the directions of NK, EF, CD, being given approximately by eye. When the angle AVG is small (as in the figure), it will generally be necessary to find P, Q, R, and fix the directions in which to measure NK, EF, CD. When the angle AVG is large (greater than 60°) and the distances NK, EF, CD are not large, it will often be unnecessary to do this. No fixed rule can be given as to when approximate methods shall be used. Experience educates the judgment so that each case is settled upon its merits.

133. Problem. *Given two tangents to a parabola, also the positions of P.C. and P.T.*
Required to lay out the parabola by "middle ordinates."



The ordinates are taken from the middle of the chord, and parallel to GV in all cases.

Field-work.

(*a*) Establish H as in last problem.

(*b*) Lay off SE = $\frac{1}{4}$ HV; also TC = $\frac{1}{4}$ HV.

(*c*) Lay off UW = $\frac{1}{4}$ TC, and continue thus until a sufficient number of points is obtained.

The length of curve can be conveniently found only by measurement on the ground.

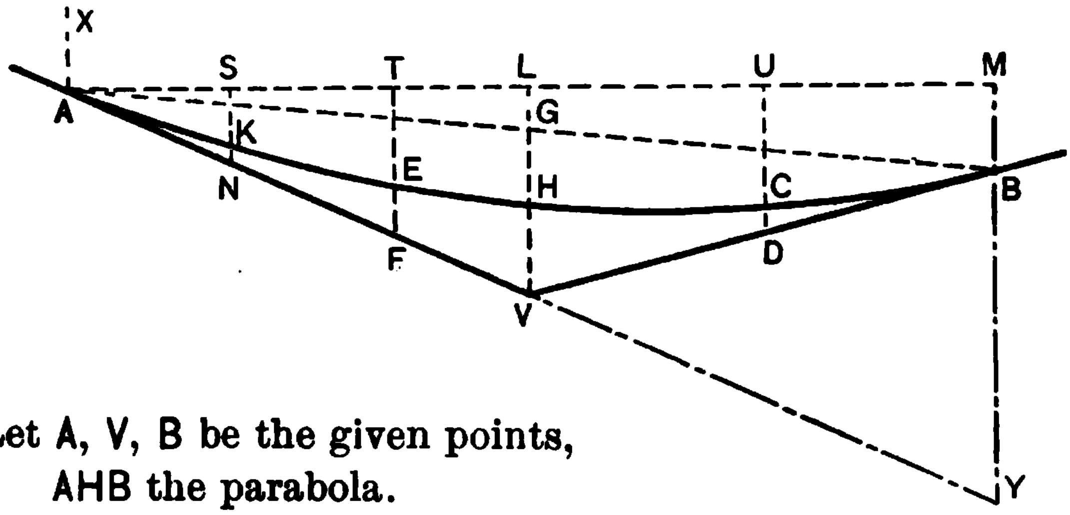
Note the difference in method between § 85 and § 133.

134. Vertical Curves.

It is convenient and customary to fix the grade line upon the profile as a succession of straight lines; also to mark the elevation above datum plane of each point where a change of grade occurs; also to mark the rates of grade in feet per station of 100 feet. At each change of grade a vertical angle is formed. To avoid a sudden change of direction it is customary to introduce a vertical curve at every such point where the angle is large enough to warrant it. The curve commonly used for this purpose is the parabola. A circle and a parabola would substantially coincide where used for vertical curves. The parabola effects the transition rather better theoretically than the circle, but its selection for the purpose is due principally to its greater simplicity of application. It is generally laid to extend an equal number of stations on each side of the vertex.

135. Problem. *Given the elevations above datum plane of grade line at the vertex, and at given points at equal distances each side of vertex, as P.C. and P.T.*

Required elevation of the vertical curve opposite the vertex; also at intermediate points.



Let A, V, B be the given points,
AHB the parabola.
Join AB ; produce AV to Y.
Draw vertical lines AX, LGHV, MBY, and horizontal line ALM.
In the case of a vertical curve, the horizontal projections of AV and VB are equal, and AL = ML.

Therefore AG = GB, and AV = VY

VG is a diameter of the parabola.
AX is also a diameter.

$$HV = \frac{VG}{2}$$

$$\text{Elev. H} = \frac{1}{2}\left(\frac{\text{Elev. A} + \text{Elev. B}}{2} + \text{Elev. V}\right) \qquad (85)$$

The elevations of A, B, V, H, are all above "datum plane."
For intermediate points following § 131,
Let LU = UM.

$$\text{Elev. C} = \text{Elev. D} + \frac{HV}{4}$$

Let AS = ST = TL.

$$\text{Elev. K} = \text{Elev. N} + \frac{HV}{9}$$

$$\text{Elev. E} = \text{Elev. F} + \frac{4}{9}\,HV$$

136. Problem. *Given the rates of grade g of* AV ; *g' of* VB ; *the number of stations n, half on each side of vertex, covered by the vertical curve ; also the elevation of the point* A.
Required the elevation, at each station, of the parabola AB.

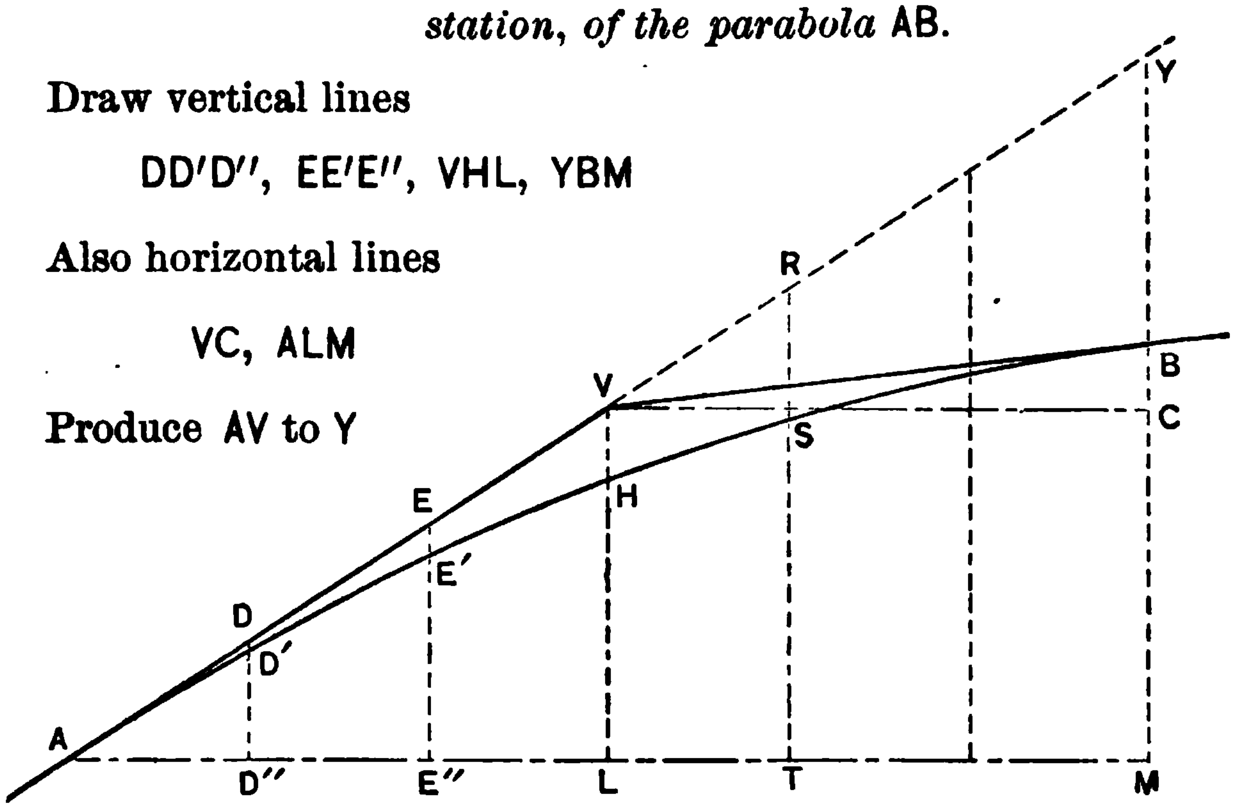
Draw vertical lines

DD′D″, EE′E″, VHL, YBM

Also horizontal lines

VC, ALM

Produce AV to Y



Let $\qquad a_1 =$ offset DD′ at the first station from A.

$\qquad\qquad a_2 =$ " EE′ " second " " A, etc.

Then

$$a_2 = 2^2 a_1 = 4\,a_1$$

$$a_3 = 3^2 a_1 = 9 a_1$$

$$a_n = n^2 a_1 = \mathrm{YB}$$

$$\mathrm{YB} = \mathrm{YC} - \mathrm{BC}$$

$$n^2 a_1 = \frac{ng}{2} - \frac{ng'}{2}$$

$$a_1 = \frac{g - g'}{2\,n} \tag{86}$$

Due regard must be given to the signs of both g and g' in these formulas, whether + or −.

From the elevation at A we may now find the required elevations, since we have given g

and we also have $\qquad a_1$

$$a_2 = 4\,a_1$$

$$a_3 = 9\,a_1 \text{ etc.}$$

A method better and more convenient for use is given below.

$$\begin{aligned}
DD'' &= g\,; & D'D'' &= g - a_1 \\
EE'' &= 2\,g\,; & E'E'' &= 2\,g - a_2 = 2\,g - 4\,a_1 \\
VL &= 3\,g\,; & HL &= 3\,g - a_3 = 3\,g - 9\,a_1
\end{aligned}$$

Again,

$$\begin{aligned}
D'D'' &= g - a_1 &&= g - a_1 \\
E'E'' - D'D'' &= 2\,g - 4\,a_1 - (g - a_1) &&= g - 3\,a_1 \\
HL - E'E'' &= 3\,g - 9\,a_1 - (2\,g - 4\,a_1) &&= g - 5\,a_1
\end{aligned}$$

On a straight grade, the elevation of any station is found from the preceding, by adding a constant g.

On a vertical curve, the elevation of each station is found from the preceding by adding, in a similar way, not a constant, but a varying increment, being for the

$$\left.\begin{array}{ll}
\text{1st station from } A = g - a_1 \\
\text{2d} \quad \text{“} \quad \text{“} \quad A = g - 3\,a_1 \\
\text{3d} \quad \text{“} \quad \text{“} \quad A = g - 5\,a_1
\end{array}\right\} \begin{array}{l}\text{changing by successive} \\ \text{differences of } 2\,a_1 \text{ in} \\ \text{each case.}\end{array}$$

137. The Am. Ry. Eng. Assn. states as to length of vertical curves that "on Class *A* roads" (roads with large traffic) "rates of change of 0.10 per station on summits, and 0.05 per station in sags should not be exceeded. On minor roads 0.20 per station on summits, and 0.10 per station in sags may be used." With very steep grades, however, even higher rates than recommended by the Association may sometimes seem necessary.

The "rate of change per station" corresponds to $2\,a_1$ in the foregoing formulas.

Let r = rate of change per station.

Then from (86)
$$r = \frac{g - g'}{n}$$

Also
$$n = \frac{g - g'}{r} \qquad (87)$$

From practical considerations the vertical curve will, in general, extend an equal number of full stations on each side of the vertex.

Then *n must be an even number* (not odd)

$$n = \frac{g - g'}{r} \tag{88}$$

The rates of grade around the curve will be

$$g - \tfrac{1}{2}r; \quad g - 1\tfrac{1}{2}r; \quad g - 2\tfrac{1}{2}r, \text{ etc.}$$

Each rate differing by r from the preceding.

138. Example.

Given. Grades as follows:

Sta.	Elev.	Rate
5	117.00	
		+ 1.00
10	122.00	
		+ 0.40
15	124.00	

Then $n = 10\,(g - g')$
$= 10 \times 0.60$
$= 6$

$a_1 = \tfrac{1}{2}r = \dfrac{g - g'}{2\,n}$
$= \dfrac{0.60}{12}$
$= 0.05$

$r = 0.10$

Sta.	Elev.		
5	117.00		
	+ 1.00		$= g$
6	118.00		
	+ 1.00	1.00	$= g$
7	119.00	− 0.05	$= \tfrac{1}{2}r$
	+ 0.95	0.95	$= g - \tfrac{1}{2}r$
8	119.95	− 0.10	$- r$
	+ 0.85	0.85	$g - 1\tfrac{1}{2}r$
9	120.80	− 0.10	$- r$
	+ 0.75	0.75	$g - 2\tfrac{1}{2}r$
10	121.55	− 0.10	
	+ 0.65	0.65	
11	122.20	− 0.10	
	+ 0.55	0.55	
12	122.75	− 0.10	
	+ 0.45	0.45	
13	123.20	End of curve	
	+ 0.40		$= g'$
14	123.60		
	+ 0.40		
15	124.00		

The elevation for Sta. 15 thus obtained agrees with the elevation shown in the data. All the intermediate elevations are therefore "checked."

CHAPTER VIII.

TURNOUTS.

139. A Turnout is a track leading from a main or other track.

Turnouts may be for several purposes.

I.	*Branch Track*	(for line used as a Branch Road for general traffic).
II.	*Siding*	(for passing trains at stations, storing cars, loading or unloading, and various purposes).
III.	*Spur Track*	(for purposes other than general traffic, as to a quarry or warehouse).
IV.	*Cross Over*	(for passing from one track to another, generally parallel).

The essential parts of a turnout are

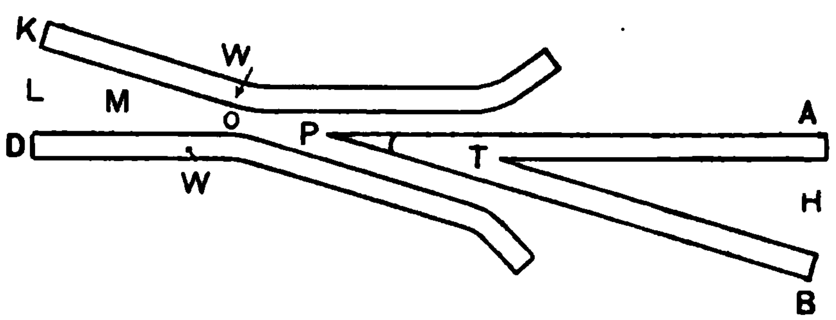
1. *The Switch.* 2. *The Frog.* 3. *The Guard Rail.*

1. Some device is necessary to cause a train to turn from the main track; this is called the "*Switch.*"

2. Again, it is necessary that one rail of the turnout track should cross one rail of the main track; and some device is necessary to allow the flange of the wheel to pass this crossing; this device is called a "*Frog.*"

3. Finally, if the flange of the wheel were allowed to bear against the point of the frog, there is danger that the wheel might accidentally be turned to the wrong side of the frog point. Therefore a *Guard Rail* is set opposite to the frog, and this prevents the flange from bearing against the frog point.

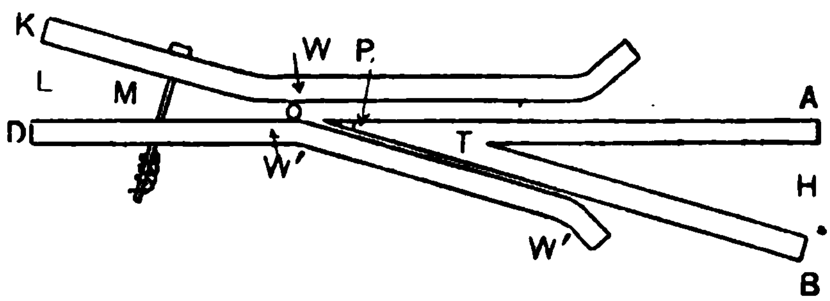
Frogs are of various forms and makes, but are mostly of this general shape, and the parts are named as follows: —



P = point
T = tongue
L = toe
H = heel
M = mouth
O = throat
WW = wings

This shows the "stiff" frog.

The "spring" frog is often used where the traffic on the main line is large, and on the turnout small. In the spring frog W′W′ is movable. AD represents the main line, and W′W′ is pushed aside by the wheels of a train passing over the turnout.

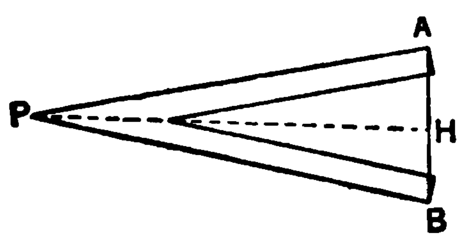


Frogs are made of certain standard proportions, and are classified by their number.

The "*Number*" n of a frog is found by dividing the length of the tongue by the width of the heel; $n = \frac{\text{PH}}{\text{AB}} = \frac{\text{LH}}{\text{KD} + \text{AB}}$.

The "*Frog angle*" is the angle between the sides of the tongue of the frog = APB.

140. Problem. *Given n. Required Frog Angle F.*



$$\cot \tfrac{1}{2} F = \frac{\text{PH}}{\frac{1}{2}\text{AB}}$$

$$\cot \tfrac{1}{2} F = 2n \qquad (89)$$

The frog is not brought to a fine "theoretical" point or edge; but is left blunt at the "actual" point; present practice leaves the frog one half inch thick at the actual point.

Let $\quad b$ = thickness at actual point.

Then $\quad nb$ = distance, theoretical to actual point of frog.

141. The form of switch commonly used at the present time is the "split switch." Fig. A shows the switch set for the turnout, and Fig. B for the main line. With the split switch the

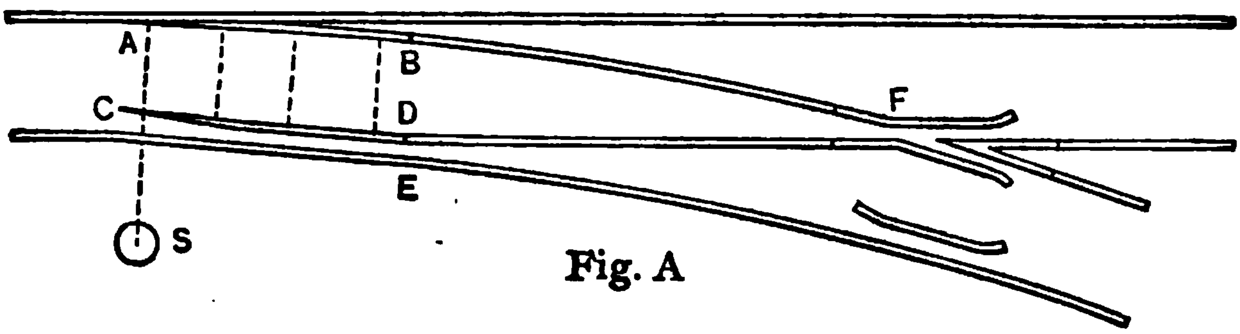


Fig. A

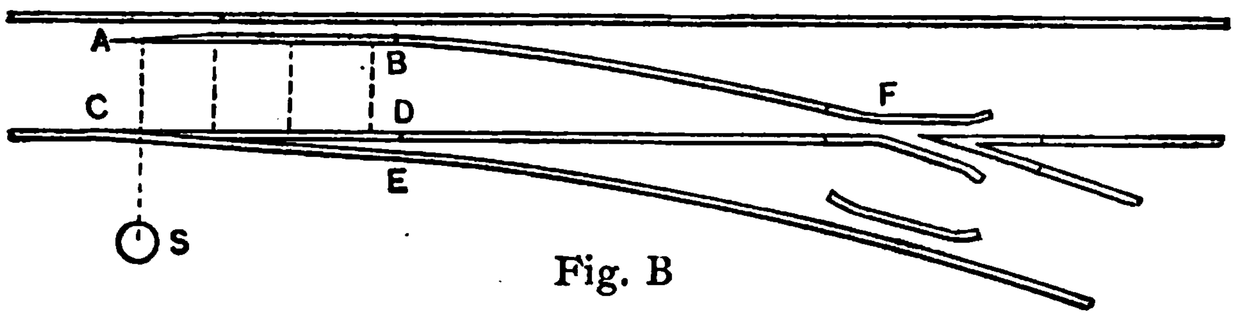


Fig. B

outer rail of the main line and the inner rail of the turnout curve are continuous. The switch rails, AB and CD, are each planed down at one end to a wedge point, so as to lie, for a portion of their length, close against the stock rail, and so guide the wheel in the direction intended. An angle, called the switch angle, is thus formed between the gauge lines of the stock rail and the switch rail, as DCE of Fig. B. The switch rails are connected by several tie rods, and one of the rods, near the point, is connected with another rod which goes to the switch stand S (or to a connection with the interlocking tower) from which the point of switch is thrown either for main track or for turnout as desired. The joint between the fixed end of the switch rail and the connecting rail, at B or D, is not bolted tight enough to prevent the slight motion of the switch rail necessary. The switch rail thus fastened at the end B is not spiked at all for its entire length, and acts as a hinged piece. Both rails thus move together, and through their entire length slide on flat steel plates provided for that purpose. The fixed (or hinged) end of this rail B is placed far enough from the stock rail to allow satisfactory spiking, frequently $5\frac{1}{2}$ or 6 inches. The length of switch rail varies from 11 feet to 33 feet in the standards of the American Railway Engineering Association.

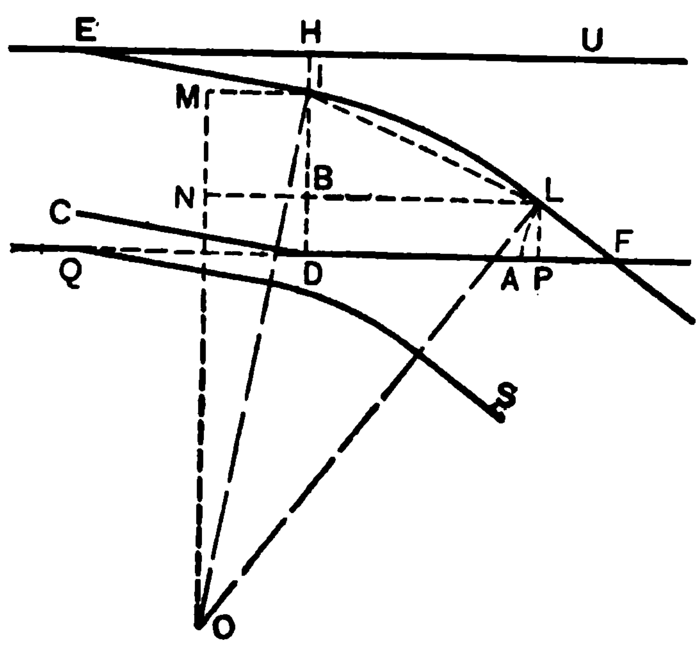
The switch rail is not planed to a fine edge but is left with appreciable thickness, frequently one quarter of an inch. The point is not left really blunt but is shaped down through a short distance from the point so that the wheel flange shall safely pass by.

In the case of the frog it seems necessary to distinguish carefully between the theoretical point and the actual point. With the switch there is no occasion to consider the theoretical point; the actual point, or the movable end of the switch rail, is the only point necessary to consider.

In laying out a turnout from a straight track, the switch rail is straight; the frog is also straight; a circular curve, called the lead curve, is introduced to connect these, and lie tangent to them.

142. Problem. *Given in a turnout, the gauge of track g; length of switch rail l; thickness at point w; heel distance between gauge sides of rails t; distance from theoretical point to toe of frog k; frog angle F and number n; thickness of frog at its point b.*

Required, radius of lead curve R; also lead E from point of switch to theoretical point of frog, and also to actual point of frog.



Let EILF and CDF be the rails of turnout,

EI and CD the switch rails.

ID is perpendicular to QDF.

Draw parallels and perpendiculars IM, LN, OM, LP, also arc LA.

Let S = switch angle HEI,

t = heel distance HI,

l = EI = QD = CD,

w = thickness of switch rail at E.

$$\sin S = \frac{t - w}{l}. \tag{90}$$

$$\mathsf{MN} = \mathsf{HD} - \mathsf{HI} - \mathsf{LP} = \qquad \mathsf{MO} \qquad - \qquad \mathsf{NO}$$

$$= g - t - k \sin F = \left(R + \frac{g}{2}\right) \cos S - \left(R + \frac{g}{2}\right) \cos F$$

$$R + \frac{g}{2} = \frac{g - t - k \sin F}{\cos S - \cos F} = \frac{g - t - k \sin F}{2 \sin \frac{1}{2}(F + S) \sin \frac{1}{2}(F - S)} \tag{91}$$

Let E_t = lead, point of switch to theoretical point of frog

E_a = lead, point of switch to actual point of frog

$$\mathsf{QF} = \mathsf{QD} + \qquad \mathsf{BL} \qquad + \qquad \mathsf{PF}$$

$$= \mathsf{QD} + \frac{\mathsf{IB}}{\tan \mathsf{ILB}} + \mathsf{LF} \cos \mathsf{LFP}$$

$$E_t = l + \frac{g - t - k \sin F}{\tan \frac{1}{2}(F + S)} + k \cos F \tag{92}$$

$$E_a = l + \frac{g - t - k \sin F}{\tan \frac{1}{2}(F + S)} + k \cos F + bn \tag{93}$$

143. *Given for the above turnout, F, S, g, k, E_a*
Required in the figure above, the closure DA *between heel of switch rail and toe of frog; also closure* IL *of curved rail.*

$$\mathsf{DA} = E_a - l - k - bn \tag{94}$$

$$\mathsf{IL} = \left(R + \frac{g}{2}\right) \text{angle } (F - S)$$

Since DA as computed is independent of R and IL is dependent upon R, any lack of precision in computing R will affect the difference between DA and IL, and I will not be exactly opposite D, as assumed.

The difference between IL and DA may be conveniently found with adequate precision as follows:

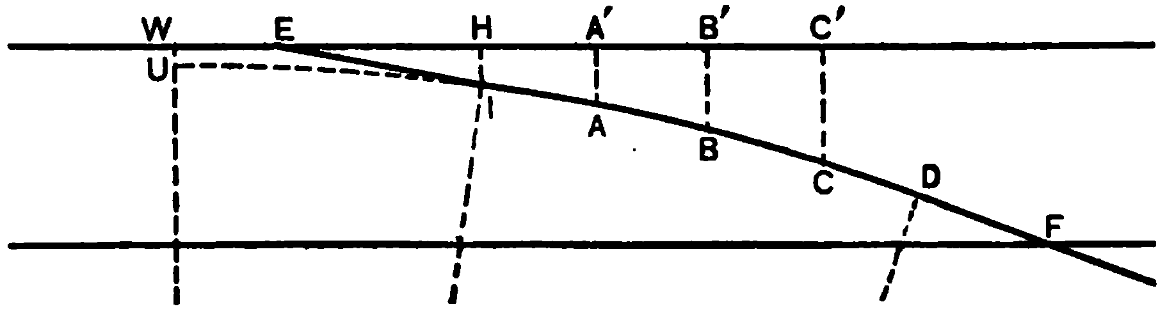
$$\mathsf{DA} = \qquad \mathsf{NL} \qquad - \qquad \mathsf{MI} \qquad - \qquad \mathsf{AP}$$

$$= \left(R + \frac{g}{2}\right) \sin F - \left(R + \frac{g}{2}\right) \sin S - k \text{ vers } F$$

$$\mathsf{IL} = \left(R + \frac{g}{2}\right) \text{angle } (F - S)$$

$$\mathsf{IL} - \mathsf{DA} = \left(R + \frac{g}{2}\right) [\text{angle } (F - S) - \sin F + \sin S] + k \text{ vers } F \tag{95}$$

144. *Given for a turnout, R, l, t, S.*
Required co-ordinates to curved rail at quarter points A, B, C.



Consider center of curve to be marked O.
Produce curve DI to U where it is parallel to EH.
Draw perpendiculars IH, AA′, BB′, CC′.

$$\text{UW} = t - \left(R + \frac{g}{2}\right) \text{vers } S = a \tag{96}$$

$$\text{EW} = \left(R + \frac{g}{2}\right) \sin S - l = d \tag{97}$$

$$\text{IOD} = F - S$$

$$\text{UOA} = S + \tfrac{1}{4}(F - S) \qquad \text{UOB} = \text{UOA} + \tfrac{1}{4}(F - S)$$

$$\text{UOC} = \text{UOB} + \tfrac{1}{4}(F - S) \qquad \text{UOD} = \text{UOC} + \tfrac{1}{4}(F - S)$$

$$= F \text{ (for a check)}$$

$$\text{EH} = l \qquad \text{(without error of more than 0.01 foot)}$$

$$\text{EA}' = \left(R + \frac{g}{2}\right) \sin \text{UOA} - d \qquad \text{AA}' = \left(R + \frac{g}{2}\right) \text{vers UOA} + a$$

$$\text{EB}' = \left(R + \frac{g}{2}\right) \sin \text{UOB} - d \qquad \text{BB}' = \left(R + \frac{g}{2}\right) \text{vers UOB} + a$$

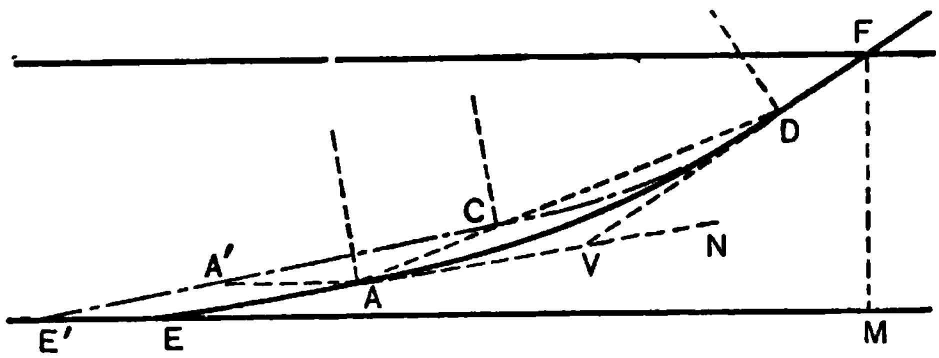
$$\text{EC}' = \left(R + \frac{g}{2}\right) \sin \text{UOC} - d \qquad \text{CC}' = \left(R + \frac{g}{2}\right) \text{vers UOC} + a$$

145. To avoid cutting rails, one or the other of the "closure" rails between heel of switch and toe of frog may be made full feet without fractions. By lengthening the tangent of the switch rail beyond the heel, the lead is increased; by lengthening the tangent of the frog back of the toe, the lead is decreased. The leads found in this way are called "practical leads"; the leads previously considered are called "theoretical leads."

The Am. Ry. Eng. Ass'n has adopted certain combinations of switches and frogs as "standard" and calculated a table of radii, leads (both theoretical and practical), and co-ordinates of quarter points. Table XXII A and XXII B show these.

Problem. *Given the increase of lead necessary to secure practical lead; also F, S, l, t, k, g.*

Required, increase of tangent past heel of switch.



Let EM = theoretical lead; E'M = practical lead

EADF and E'A'CDF be the corresponding turnouts

EA $= l$; E'C $= l'$

Draw parallel AA'; chords AD, CD; tangents AVN, DV

Then E'E = given increase of lead; A'C = required increase of tangent; DVN $= F - S$

ADV = CDV $= \frac{1}{2}(F - S)$ and AC and AD coincide

In triangle A'AC, A'CA $= \frac{1}{2}(F - S)$; CA'A $= S$; A'A = E'E

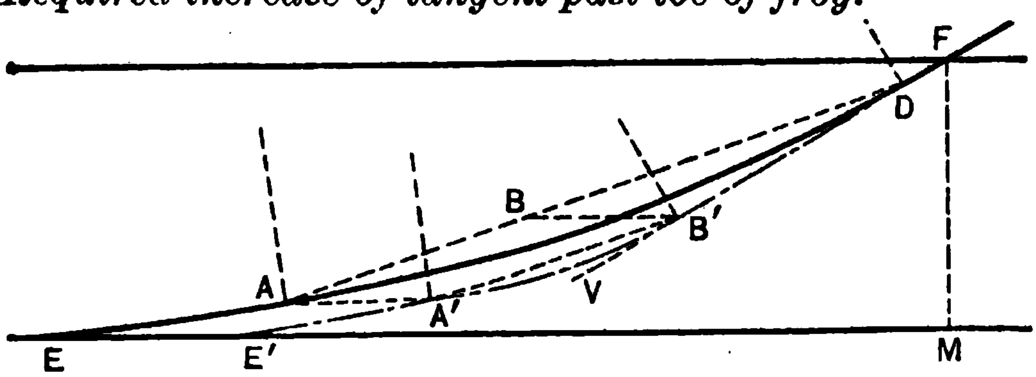
$$A'C = \frac{E'E \sin \frac{1}{2}(F + S)}{\sin \frac{1}{2}(F - S)} = l' - l \qquad (98)$$

Following (91) $$R + \frac{g}{2} = \frac{g - t - (l' - l) \sin S - k \sin F}{2 \sin \frac{1}{2}(F + S) \sin \frac{1}{2}(F - S)} \qquad (99)$$

For finding co-ordinates of quarter points, use instead of (96) the following $a = t + (l' - l) \sin S - \left(R + \frac{g}{2}\right)$ vers S (96 A)

146. Problem. *Given the decrease of lead necessary to secure practical leads; also F, S, l, t, k, g.*

Required increase of tangent past toe of frog.

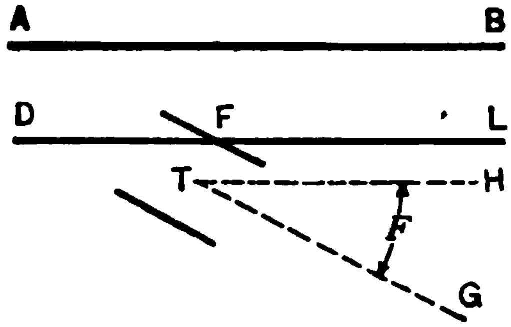


Let DF $= k$ and B'F $= k'$ From the figure it may be found that

$$B'D = \frac{E'E \sin \frac{1}{2}(F + S)}{\sin \frac{1}{2}(F - S)} = k' - k \qquad (100)$$

$$\frac{g - t - k' \sin F}{2 \sin \frac{1}{2}(F + S) \sin \frac{1}{2}(F - S)} = R + \frac{g}{2} \qquad (101)$$

147. It has become the custom to stake out the position of the frog point F. From this point F, a good track foreman will work backward and lay out the turnout according to the standard plan.



For any continuance of turnout beyond the point of frog, where this is a matter of fieldwork, a very common practice is as follows:

(*a*) Set the transit opposite the point of frog, at T.

(*b*) Lay off on the transit (on the proper side of 0°) the value of the frog angle *F*.

(*c*) Sight in the direction TH, parallel to AB.

(*d*) Turn off HTG = *F*.

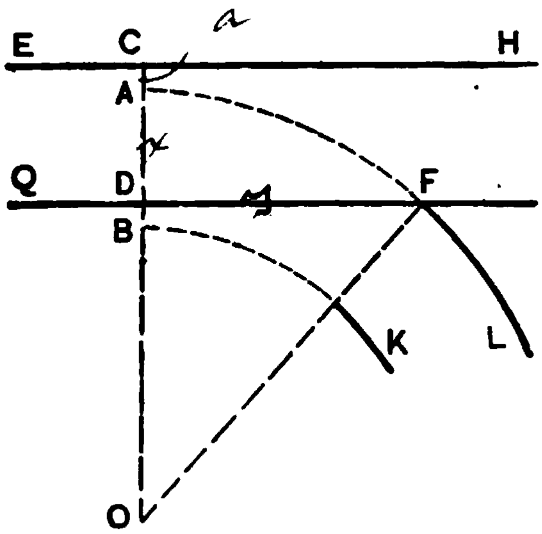
(*e*) The transit then sights along TG with vernier at 0°.

Any curve desired may then be laid off conveniently by deflection angles, and this curve will connect at T (opposite F) with whatever arrangement of track extends backward from the point of frog to the point of switch. Where the line in advance of F is new location, TG is the basis for that location; TG is either continued as a straight line, or it becomes the tangent to a desired curve and the transit is already set on TG with the vernier at 0°. When the turnout is to connect with some track parallel to the main track, the simplest method is to resolve the problem into a case of reversed curves with parallel tangents, by the following method, similar to that of § 125. If the curve used beyond F is extended backward toward the point of switch until it becomes parallel to the main track, the outer rail of this curve will not, in general, be tangent to the corresponding rail of the main track, but there will be an offset by a small distance which we may call a, and the reversed curve must be figured for a distance between parallels of $p - a$, rather than p, the actual distance between parallel tracks. If there be a turnout at each of the parallel tracks, $p - 2a$ should be used.

This method of treatment is not dissimilar to the use of p and q in spirals, and has value in many cases other than those of parallel tracks; several cases will be treated in the next chapter.

The method of finding a follows.

148. Problem. *Given a curve of radius R to be used beyond the frog; also F, n, g, b.*
Required the co-ordinates (from the frog point) of the point where the given curve produced backward becomes parallel to the main track.



Let LF be outer rail of given curve with center at O

EH, QF, rails of main track

Produce curve LF to A where it becomes parallel to EH, and draw OC perpendicular to EH

Let CA $= a$; FD $= y$

AD $= x$

To theoretical point of frog $$y_t = \left(R + \frac{g}{2}\right) \sin F \qquad (102)$$

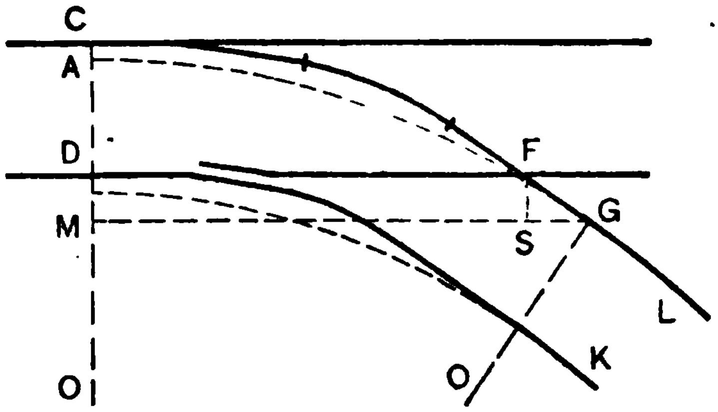
To actual point $$y_a = \left(R + \frac{g}{2}\right) \sin F + nb \qquad (103)$$

$$x = \left(R + \frac{g}{2}\right) \text{vers } F \qquad (104)$$

$$g - x = a = g - \left(R + \frac{g}{2}\right) \text{vers } F \qquad (105)$$

If the curve produced backward becomes parallel above the rail ECH, the value of a becomes *minus* and where the problem is for a reversed curve between parallel lines the perpendicular distance used must be the distance between parallel lines $p + a$ rather than $p - a$. Where the curve to be used beyond the frog point has a large radius, the value of a will probably be *minus*.

With this method, the main track is used as a base-line and the point of frog the standard reference point; this corresponds with present good practice. If F be staked out on the ground or its position determined in the office, the position of point A is readily found by y, x, a. Conversely, if the position or station of A is found by computation, F is also determined. The entire split-switch turnout may then be laid out from F as a starting point and from QF or EH as reference lines.



149. If it be desired to use greater precision, and take into account the fact that the frog is straight from theoretical point F to heel G, and to make the curve beyond the frog tangent to FG at G,

Let $\mathsf{FG} = h$

Then $\mathsf{AD} = x = \left(R + \frac{g}{2}\right) \text{ vers } F - h \sin F$

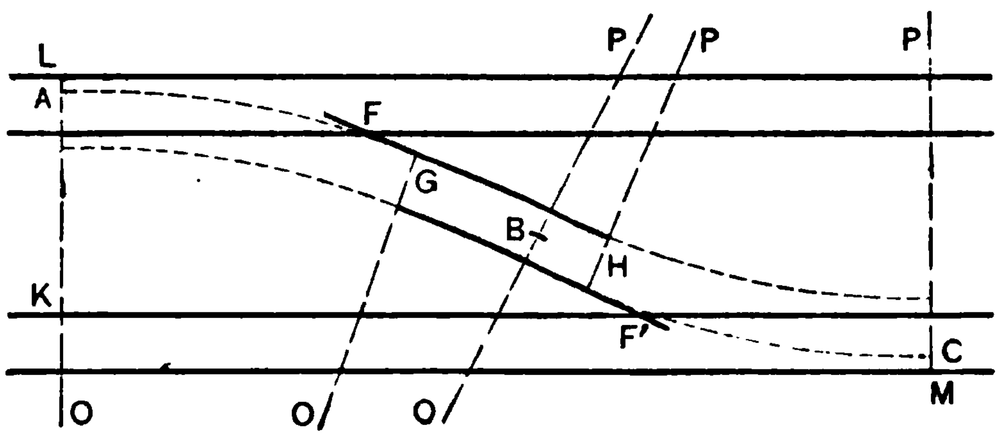
$$\mathsf{FD} = y_t = \left(R + \frac{g}{2}\right) \sin F - h \cos F$$

$$y_a = \left(R + \frac{g}{2}\right) \sin F - h \cos F + nb \tag{106}$$

$$g - x = g - \left(R + \frac{g}{2}\right) \text{ vers } F + h \sin F = a \tag{107}$$

150. Problem. *Given the radii R_1, R_2, of two parts of a reversed curve extending from heel of frog to heel of frog between parallel tracks; also unequal frog angles F, F'; also h, h', also perpendicular distance between tracks p, and gauge g.*

Required angles GOB *and* BPH.



Let G and H be heels of frogs F and F′

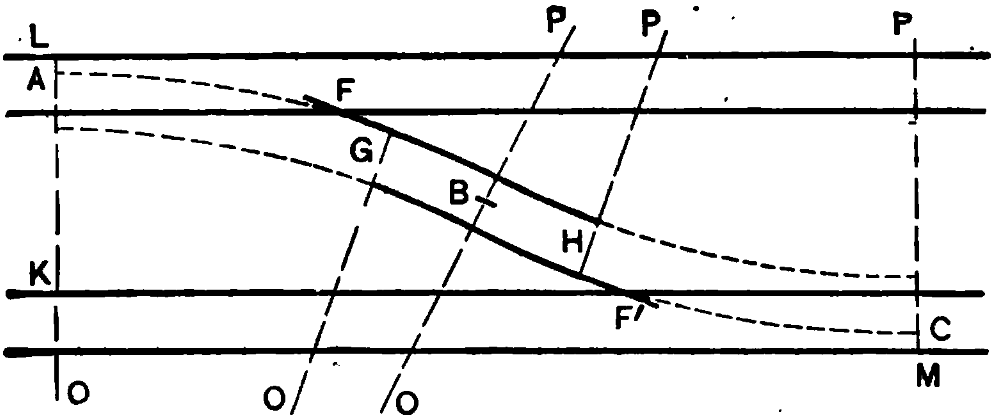
$\mathsf{LK} = p$; $\mathsf{OB} = R_1$; $\mathsf{PB} = R_2$

Find $\mathsf{LA} = a_1$ and $\mathsf{MC} = a_2$ by (107)

From (76) $\text{vers AOB} = \dfrac{p - a_1 - a_2}{R_1 + R_2}$ (108)

$$\mathsf{GOB} = \mathsf{AOB} - F \text{ and } \mathsf{BPH} = \mathsf{AOB} - F'$$

151. More commonly the two frogs will have the same number and the radii of the reversed curve will be the same.



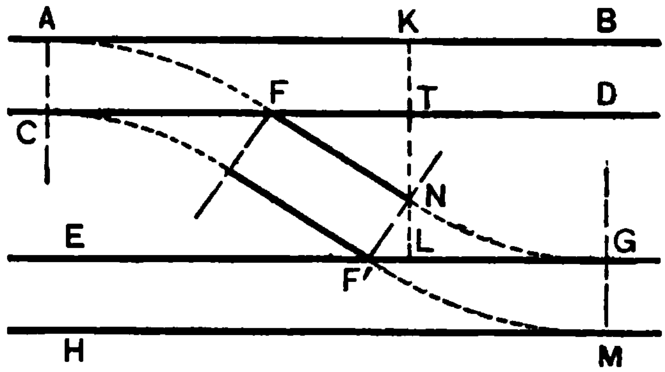
When $F = F'$ and $R_1 = R_2$

$$\text{vers AOB} = \frac{p - a - a}{R_1 + R_2} = \frac{\frac{1}{2}p - a}{R} \qquad (109)$$

$$\text{GOB} = \text{BPH} = \text{AOB} - F$$

152. Problem. *Given $F = F'$, n, b; also p, g.*

Required the length l, of tangent between the two frogs.



Let F and F′ be theoretical points of frogs

Draw KTNL perpendicular to AB

Then
$$\text{TN} = \text{KL} - \text{KT} - \text{NL}$$
$$\text{FN} \sin \text{TFN} = p - g - \text{F'N} \cos \text{F'NL}$$
$$l \sin F = p - g - g \cos F$$
$$l = \frac{p - g - g \cos F}{\sin F} \qquad (110)$$

l is the distance from the theoretical point at F to point N opposite the theoretical point at F′

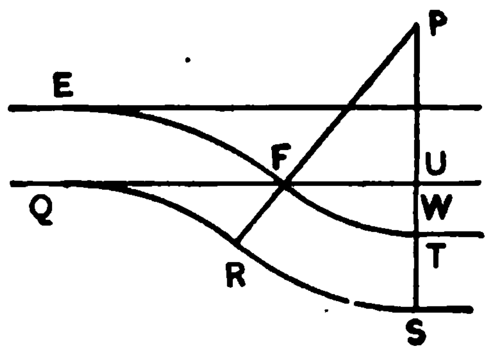
The above solution holds good whatever be the turnout used.

For a crossover between existing tracks, if the distance FF′ be calculated, both frog points can be located and the entire turnout staked out without transit.

from (30) $$\text{FF}' = l + \frac{g^2}{2\,l} \text{ (approx.)}$$

The distance from actual point of one frog to the actual point of the other $= \text{FF}' - 2\,nb$.

153. Problem. *Given F, n, p, g.*
Required the radius of curve R_2, to connect the parallel tangents.



If $P.R.C.$ be taken at F, the theoretical point of frog.

Then $\text{TPF} = I_r = F$

$$\text{UT} = \text{US} - \text{TS}$$

$$\left(R_2 - \frac{g}{2}\right) \text{vers } F = p - g$$

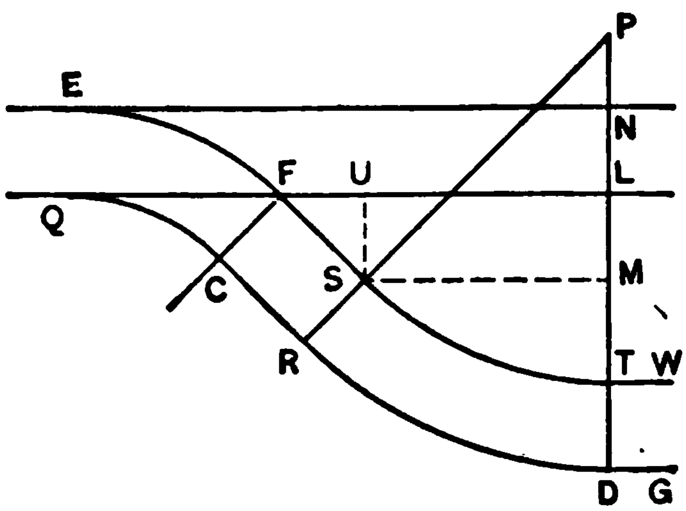
$$R_2 - \frac{g}{2} = \frac{p-g}{\text{vers } F}. \qquad (111)$$

154. *Second Solution.* $\text{UT} = p - g$; $\text{PW} = R_2 - \frac{p}{2}$

by (118) $\qquad \text{PW} = \text{UT}\ 2\,n^2$

$$R_2 - \frac{p}{2} = (p - g)2\,n^2. \qquad (112)$$

155. Problem. *Given g, p, l, F.*



Required R_2 of curve to connect parallel tangents.

Let F be the theoretical point of frog; l the distance from theoretical point of frog to S opposite $P.C.$ of curve.

Draw the perpendiculars SU, SM.

Then $\qquad \text{SU} = \text{LM} = \text{NT} - \text{NL} - \text{MT}$

$$\text{FS} \sin \text{UFS} = \text{NT} - \text{NL} - \text{PS vers SPT}$$

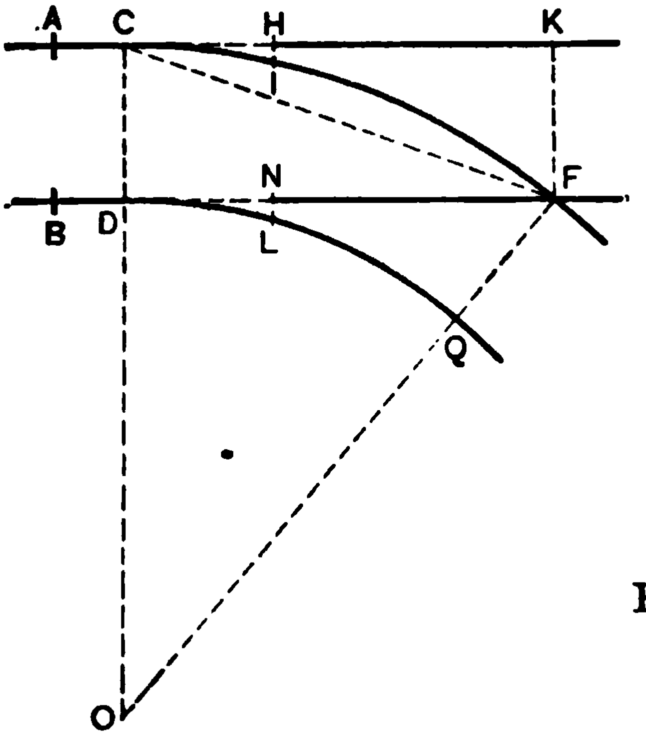
$$l \sin F = p - g - \left(R_2 - \frac{g}{2}\right) \text{vers } F$$

$$R_2 - \frac{g}{2} = \frac{p - g - l \sin F}{\text{vers } F} \qquad (113)$$

By taking FS or $l = h$ (the distance from theoretical point to heel of frog) formula (113) covers the case where the reversing curve starts from the heel of frog.

156. A form of switch formerly in common use is the "*Stub-Switch*," which is formed by two rails, one on each side of the track, called the *Switch Rails*. One end of the rail for a short distance AC or BD (perhaps 5 or 10 feet) is securely spiked to the ties, the rest of the rail CI or DL being free to slide on the ties, so that it may meet the fixed rails of either main track at H or N, or turnout at I or L, as desired. These fixed rails, supported on a heavy tie or *Head Block*, are held by a casting, or piece of metal called the *Head Chair*, upon which the switch rail slides. A *Switch Rod* connects the ends of the switch rails with the *Switch Stand*. Since one end of the rail is spiked down, when the free end is drawn over by the switch rod the rail is sprung into a curve which may with slight error be considered a circular curve, tangent to the main line (if this be straight). In the stub-switch the outer rail of the turnout is assumed to be tangent both to the main track at C and to the frog at its point F. The distance through which the free end of the rail is drawn or *thrown* by the switch rod is called the *Throw* of the switch; this will be 5 or 6 inches. The free end of the rail is called the *Toe*, and the *P.C.* of the curve the *Heel* of the switch.

157. Problem. *Given gauge of track g; frog angle F; number of frog n; and throw of switch t. Required for a stub-switch, radius of turnout curve R; length of switch rail l; and* DF, *the lead E.*



Draw perpendicular FK

$$COF = F$$

$$FO = \frac{CD}{\text{vers } COF}$$

$$R + \frac{g}{2} = \frac{g}{\text{vers } F} \qquad (114)$$

$$DF = OF \sin DOF$$

$$E = \left(R + \frac{g}{2}\right) \sin F \qquad (115)$$

From (26) $t = \dfrac{l^2}{2R}$ (approx.)

$$l = \sqrt{2Rt} \qquad (116)$$

$$\mathrm{DF} = \mathrm{CD} \cot \mathrm{CFD}; \quad E = g \cot \tfrac{1}{2} F; \quad E = 2\, gn \tag{117}$$

$$\mathrm{DF}^2 = \mathrm{FO}^2 - \mathrm{DO}^2$$

$$E^2 = \left(R + \frac{g}{2}\right)^2 - \left(R - \frac{g}{2}\right)^2$$

$$E^2 = \left(R + \frac{g}{2} + R - \frac{g}{2}\right)\left(R + \frac{g}{2} - R + \frac{g}{2}\right) = 2\, Rg$$

$$R = \frac{E^2}{2\, g} = \frac{(2\, gn)^2}{2\, g} = 2\, gn^2 \tag{118}$$

$$R = En$$

$$l = \sqrt{2\, Rt} = \sqrt{4\, n^2 gt} = 2\, n\sqrt{gt}$$

These formulas in § 156 and § 157 apply only in the case of the stub-switch, and are not to be used for split-switch turnouts.

158. Problem. *Given the degree D of a stub-switch turnout from a straight track.*
Required the degree of curve D′ for a stub-switch turnout from a curved main track of degree D_m, F, n, g, remaining the same.

It may be shown that for a turnout to the inside of the curve

$$D' = D + D_m \text{ (approx.)} \tag{119}$$

for a turnout outside the curve

$$D' = D - D_m \text{ (approx.)}$$

except that $\quad D' = D_m - D$ (approx.)

when $\quad D_m > D$

Take the case of the turnout on the inside of a curved main track.

When the main track is straight, g, the distance from frog point to the rail opposite, is the "tangent deflection" of § 70 for the outer rail of the turnout curve, whose degree is approximately D.

From (26 B) $\quad a = a_1 D$

so that $\quad g = a_1 D$

When the main line is curved, g becomes the offset between two curves, one the outer rail of the turnout curve, and the other the outer rail of main track.

Assuming the chords c for the outer rails of the turnout

curves to be equal in the two cases of straight main track and curved main track

by (27) $\qquad a_{s-l} = a_1(D_s - D_l)$

and the degree of the turnout curve must be such that

$$g = a_1(D' - D_m)$$

The values of c and E are nearly equal; so that what is true of the chord in this relation is also true of E (very closely). Therefore for a given value of E

$$D' = D + D_m \text{ (approx.)}$$

Furthermore the length of turnout curve is equal to c (very closely); for the given length $= c$ the angle $I = \frac{cD}{100} = F$, and since $D' - D_m = D$, the difference in angle $\frac{cD'}{100} - \frac{cD_m}{100} = \frac{cD}{100} = F$, so that the frog angle is not changed (materially).

Similar consideration of the two cases of turnout outside the curve of main track will show the expressions above to be true.

159. Example. Required the stub-switch turnout from a 3° main line curve using a No. 9 frog.

Table XXII shows for a No. 9 frog the

$$\begin{array}{lcl} \text{degree of curve} & = & 7^\circ 31' = D \\ \text{The degree of main line} & = & \underline{3^\circ 00'} = D_m \\ \text{degree of turnout} & = & 10^\circ 31' = D' = D + D_m \\ \text{By precise formula} & & 10^\circ 32' = D' \end{array}$$

In a similar way for a turnout on the outside of the same curve

$$D' - D_m = D = 4^\circ 31'$$

160. Another less mathematical, but very useful illustration is this: If we conceive the straight main track and the stub-switch turnout curve to be represented by a model where the rails are made of elastic material; using a "bending process" it will follow that if the main track rails be bent into a circular curve with the turnout inside, then the rails of the turnout curve will be bent into a sharper curve, and sharper by the degree of curve D_m into which the straight track is bent. Similarly when the straight track is bent in the opposite direction, the turnout curve will become flatter by the amount of D_m.

161. Problem. *Given* F, n, k, g, R_m, D_m.
Required the split-switch turnout from the given curved main track.

Tables XXII A and XXII B give, for various numbers of frog, the length of switch rail l, heel distance t, lead E, radius R and degree D of lead curve, length of frog from toe to theoretical point k; also co-ordinates to quarter points. These tables show the standards adopted by the Am. Ry. Eng. Assn. for turnouts from tangents.

For turnouts from curved tracks, applying the "bending process," l, t, k, E remain unchanged in length; this is true also of the co-ordinates at the quarter points, the y values being measured along the curved main rail and x values normal to this rail; straight rails become curved to the degree of the curved main track, track or rails already curved are bent into curves sharper than before by D_m (or flatter by D_m depending upon which side of the main track the curved track lies).

The degree of lead curve $D' = D \pm D_m$

The frog remains straight necessarily; the distance k is small for all sharp lead curves, and the resulting error will be small. Furthermore the straight frog is laid as part of the main track which is assumed to be curved, so that a correct mathematical treatment is impracticable.

The switch-rail can be and should be curved to the degree D_m. It is better to curve it in a bending machine, but it is often laid straight and the traffic depended upon to curve it to a fit against the stock rail.

162. Example. For a number 9 frog, Table XXII A gives

$$l = 16'\,6''; \;\; t = 6\tfrac{1}{4}''; \;\; k = 6'; \;\; h = 10'.$$

Table XXII B gives for "practical leads"

$$D = 9^\circ\,29'; \;\; E_a = 72.28\,;$$

the co-ordinates are

$$28.75,\ 1.02\,; \quad 40.98,\ 1.76\,; \quad 53.19,\ 2.75$$

In using a number 9 turnout inside a 2° curved track

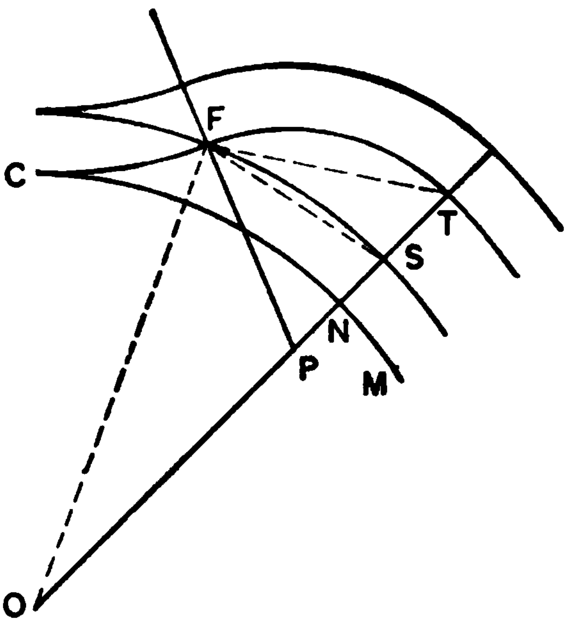
$$D' = 9^\circ\,29' + 2^\circ = 11^\circ\,29'$$

The other linear dimensions remain unchanged.

163. Problem. *Given the radial distance p between a given curved main track and a parallel siding, also frog angle F (or number n), and gauge of track g.*

Required the radius R_2' of second curve to connect point of frog with siding.

I. When the siding is **outside** the main track.



Let CM be the inner rail of the given main line.

CFT inner rail of turnout.

R_m = radius of main line.

R_2' = radius of turnout.

p = TN = radial distance.

Connect FT, FO. Join FS.

Let FOT = O.

In triangle FTO,

$$\text{FO} = R_m + \frac{g}{2} \qquad \text{TO} = R_m - \frac{g}{2} + p$$

also

$$\text{OFT} + \text{OTF} = 180^\circ - \text{FOT} = 180^\circ - O$$

$$\text{OFT} - \text{OTF} = \text{OFT} - \text{PFT} = F$$

$$\tan \tfrac{1}{2}(\text{OFT} + \text{OTF}) : \tan \tfrac{1}{2}(\text{OFT} - \text{OTF}) = \text{TO} + \text{FO} : \text{TO} - \text{FO}$$

$$\cot \tfrac{1}{2} O : \tan \tfrac{1}{2} F = 2 R_m + p : p - g$$

$$\tan \tfrac{1}{2} O = \frac{p-g}{2 R_m + p} \cot \tfrac{1}{2} F = \frac{p-g}{R_m + \frac{p}{2}} \cdot \frac{\cot \frac{1}{2} F}{2} = \frac{(p-g)n}{R_m + \frac{p}{2}} \quad (120)$$

Similarly $\qquad \text{FPT} = F + O$

In the triangle PFS, $\tan \frac{1}{2}(F + O) = \dfrac{(p-g)n}{R_2' - \frac{p}{2}}$;

$$R_2' - \frac{p}{2} = \frac{(p-g)n}{\tan \frac{1}{2}(F+O)} \quad (120) \qquad L = \frac{100\,(F+O)}{D_2'} \qquad (121)$$

Since the main track is assumed to be curved past the frog and the frog is necessarily laid straight, it seems an unnecessary refinement to assume the frog straight from point to heel in this case.

164. Example.

Turnout from curve *outside* the main track.

Let $D_m = 4$; $n = 8$; $p = 15$; $g = 4.708$

Precise Method.

$$\tan \tfrac{1}{2} O = \frac{(p-g)n}{R_m + \frac{p}{2}} = \frac{10.292}{1440.2} \times 8 = \frac{82.336}{1440.2}$$

	82.336	log 1.915590
	1440.2	log 3.158422
	$\tfrac{1}{2} O = 3° 16' 19''$	tan 8.757168
	$\tfrac{1}{2} F = 3° 34' 30''$	
$R_2' - \frac{p}{2} = \frac{(p-g)n}{\tan \frac{1}{2}(F+O)}$	$\tfrac{1}{2}(F+O) = 6° 50' 49''$	tan 9.079448
$= \frac{82.336}{\tan 6° 50' 49''}$	82.336	log 1.915590
	685.7	log 2.836142
	$\tfrac{1}{2} p = 7.5$	
	$R_2' = 693.2$	
	$D_2' = 8° 16'.4$	

$$L = \frac{100(F+O)}{D_2'} = \frac{100 \times 13° 41' 38''}{8° 16'.4} = 165.5$$

Approximate Method.

Apply the "bending process" of p. 93.

In the case of a turnout from a straight main track, where $n = 8$ and $p = 15$,

$$\text{from (112)} \quad R_2 - \frac{p}{2} = (p-g)\, 2\, n^2$$

$$= (15.0 - 4.708)\, 2 \times 64 = 1317.4$$

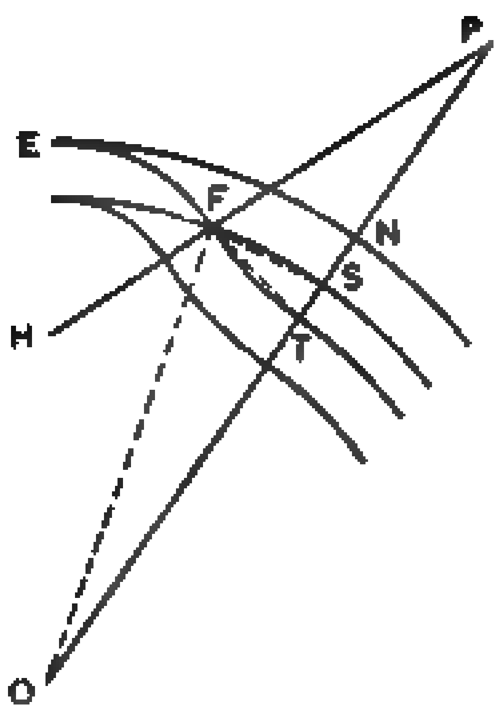
$R_2 = 1324.9$; $D_2 = 4° 19.5$; $F = 7° 09'$ (Table XXII.)

$$L = \frac{100 \times 7° 09'}{4° 19.'5} = 165.3 \text{ for straight tracks}$$

$D_2' = D_2 + D_m$

$= 4° 19' + 4° = 8° 19'$ (8° 16' precise method)

$L = 165.3$ as with straight track (165.5 precise method).



165. II. When the siding is inside the main track.

In a similar fashion it may be shown, using this figure, that

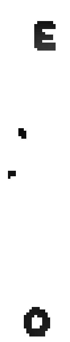
From triangle OFT

$$\tan \tfrac{1}{2} O = \frac{(p-g)n}{R_m - \frac{p}{2}} \qquad (122)$$

From triangle PFS

$$R_2' - \frac{p}{2} = \frac{(p-g)n}{\tan \frac{1}{2}(F-O)} \qquad (123)$$

$$L = \frac{100(F-O)}{D_2'} \qquad (124)$$



166. III. When the siding is outside the main track, but with the center of turnout curve inside of main track.

Let EFS be the outer rail of main track.

FT the inner rail of turnout.

From triangle OFT

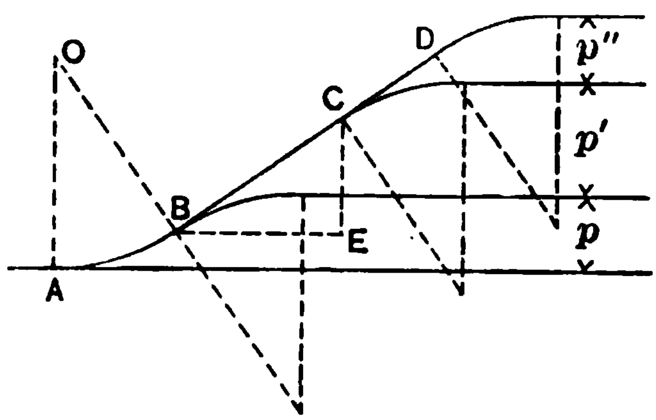
$$\tan \tfrac{1}{2} O = \frac{(p-g)n}{R_m + \frac{p}{2}} \qquad (125)$$

From triangle PFS

$$R_2' - \frac{p}{2} = \frac{(p-g)n}{\tan \frac{1}{2}(F+O)} \qquad (126)$$

$$L = \frac{100(F+O)}{D_2'} \qquad (127)$$

With both § 165 and § 166, approximate results may be reached, by using the "bending method" of p. 93. Where the radius R_2 of the second curve is large and p is small, the approximate method will be sufficiently close; where p is large, the precise method will be necessary. Experience will determine in what cases it will be sufficient to use the approximate results, and where precise formulas should be used.



167. Problem. *Given for tracks as shown in figure, the radius R of stub-switch curve, also the perpendicular distances between tracks p, p', p''; also equal frogs.*

Required AOB, BC, CD.

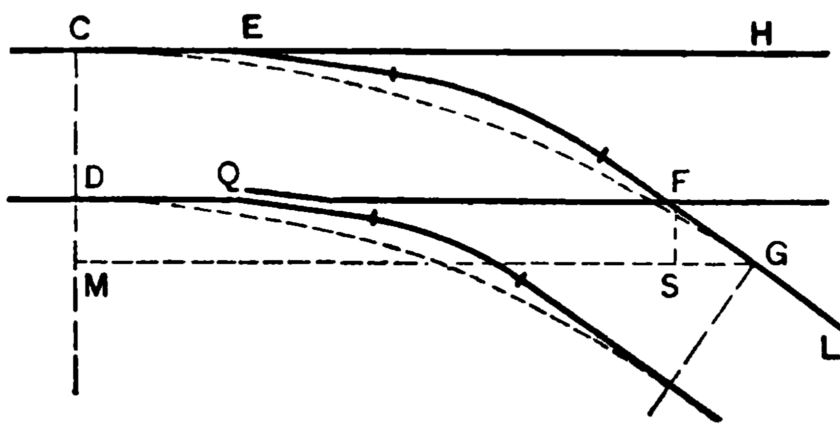
From (71) $\text{vers AOB} = \dfrac{\frac{1}{2}p}{R}$

also $\quad \text{BC} \sin \text{CBE} = \text{CE} \quad$ or $\text{BC} \sin \text{AOB} = p'$

$$\text{BC} = \frac{p'}{\sin \text{AOB}}; \quad \text{and CD} = \frac{p''}{\sin \text{AOB}} \tag{128}$$

Since the standard turnout curve extends only from heel of switch to toe of frog, any convenient curve beyond the frog is appropriate. If a curve of the same degree as the stub-switch curve be used beyond the frog point, the above formulas will apply (whatever the standard turnout curve may be), since the outer curved rail extended back comes tangent to the rail of the main track. The stub-switch curve thus is very convenient to use.

If it seems advisable to consider the frog straight from point at F to heel at G in the figure below,



Let $\text{FG} = h$

$\text{CM} = g + h \sin F$

$R = 2\,n^2(g + h \sin F)$

This is the radius of the curve whose outer rail is tangent to the rail of the main track and also to the frog at its heel G.

For a series of tracks like those above when the main track is curved, the computations may be made for straight tracks and the bending process applied. Just how far this process may be carried will be determined by experience.

In a freight yard the tracks on which cars are stored are called "body tracks" and the track which leads to, and connects with, these body tracks is called the "ladder track." The track AD, § 167, is a ladder track.

When the ladder track leaves the main track in a straight line from the theoretical point of frog, if the body tracks are laid parallel to the main track, they may be laid out in straight lines from the theoretical point of the frogs used for the turnouts to these body tracks. With frogs of numbers commonly used in such cases, the distance BC or CD will be sufficient so that there will be plenty of room between the heel of frog and the point of the switch rail following it. For example, the parallel body tracks are seldom less than 12 ft. between centers; with a No. 8 frog and $p = 12$ ft. BC will be 96.4 ft.

The practical lead (Table XXII B) will be 68.0 ft.; from theoretical point to heel of frog will be (Table XXII A) 8.8 ft. Practical considerations involving bending the stock rail demand that the point of switch shall lie fully 4 ft. beyond the rail just at the heel of frog.

It is necessary, therefore, that on a ladder track the distance from the point of one switch to the point of the next switch shall not be less than $68.0 + 8.8 + 4.0 = 80.8$ ft. where a No. 8 frog is used. Since there is 96.4 ft. available and 80.8 ft. only needed, this arrangement of tracks leaves ample room.

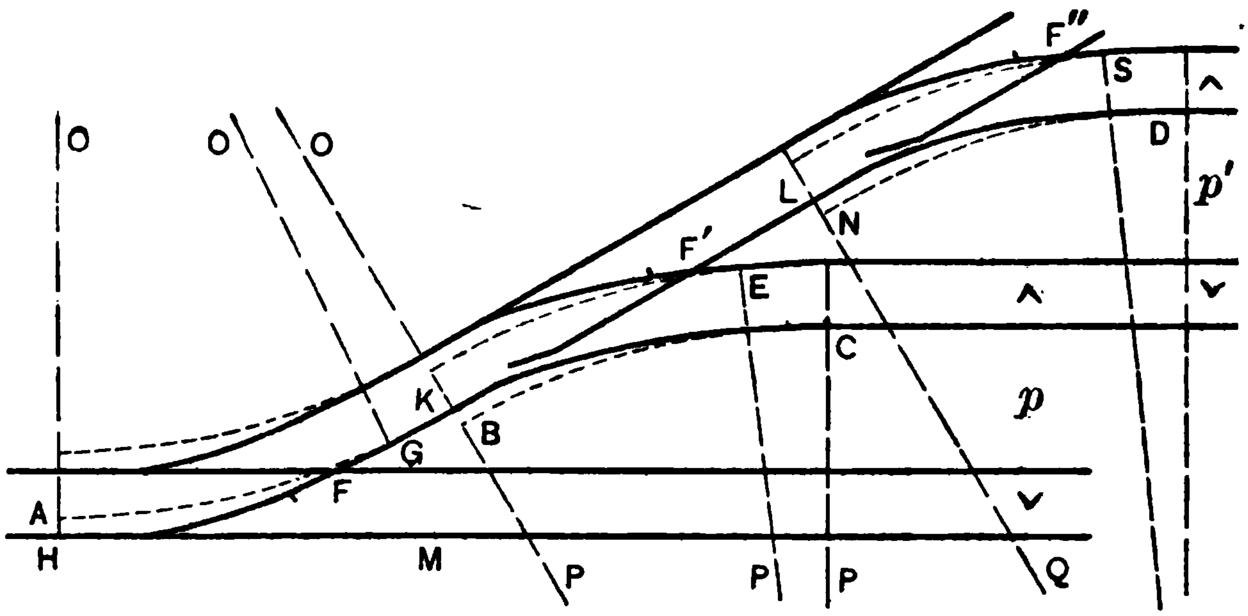
If the angle the ladder track makes with the main track be increased, the body tracks are lengthened and the ladder track becomes shorter; both of these results are of value. In the case taken above the angle can be increased until $\sin I = \frac{12}{80.8}$ or $I = 8° 32'$, or in general terms let q = clearance required from heel of frog to next point of next switch, then

$$\sin I \leqq \frac{p}{E_t + h + q}$$

It will be necessary also that I shall not exceed the value of AOB in § 167.

The arrangement of a series of body tracks and the ladder tracks allows an opportunity, in many cases, for careful study and much ingenuity; an extended treatment here will not be justified.

168. Problem. *Given for tracks shown in figure the radius R of the curve beyond the heel of frog; also p, p' between parallel tracks; also F, n, g. Required angle* AOK *and distance* F′F″.



Let GK with its center at O be outer rail of the given curve of radius R.

Produce this curve to A when it is parallel to HM.

Let BC with center at P, and ND with center at Q, be similar curves produced.

Let FG, F′E, F″S be straight lines from theoretical point to heel of frogs.

$$\text{OA} = R + \frac{g}{2};\ \text{BP} = \text{NQ} = R - \frac{g}{2};\ \text{AH} = \text{KB} = \text{LN} = a$$

Find a by (107).

$$\text{OP} = R + \frac{g}{2} + a + R - \frac{g}{2} = 2R + a$$

Then by (76) $$\text{vers AOK} = \frac{p}{2R + a} \qquad (129)$$

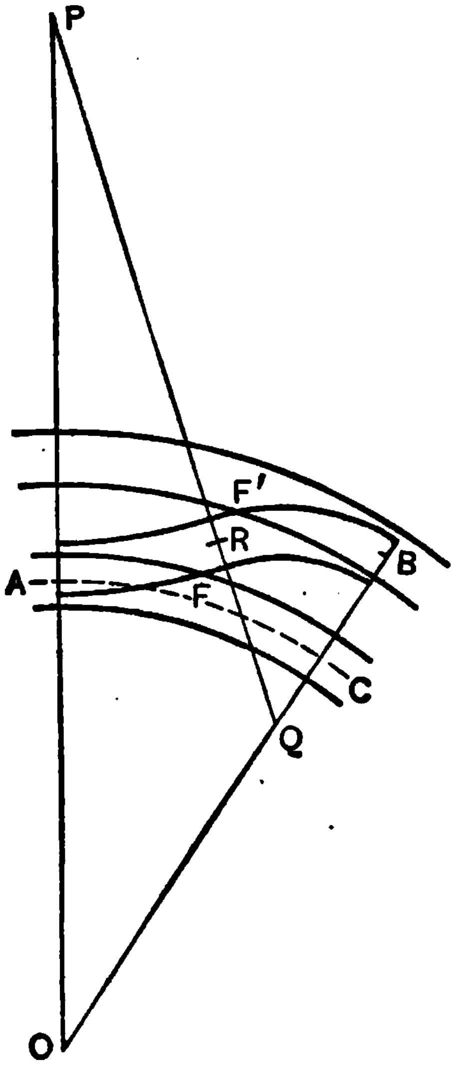
oy (128) $$\text{KL} = \frac{p'}{\sin \text{AOK}}$$

Since KF′ = LF″ $$\text{KL} = \text{F}'\text{F}'' = \frac{p'}{\sin \text{AOK}} \qquad (130)$$

169. Problem. *Given the radial distance between a curved main track and a parallel siding.*

The two tracks are to be connected by a cross-over, which shall be a reversed curve of given unequal radii beyond the frogs.

Required the central angle of each curve of the reversed curve.



Let AC = center line of inner track.

AO = R_m; RP = R_1'; RQ = R_2'

R_1' and R_2' are the radii of the curves beyond the frogs and may be assumed as any reasonable values.

Find a_1 and a_2 by applying the "bending process" (p. 93) and then (105) or (107).

Then in the triangle POQ find

$$PO = R_m + R_1' + a_1$$
$$PQ = R_1' + R_2'$$
$$OQ = OC + CB - BQ$$
$$= R_m + p - R_2' - a_2$$

Solve for OPQ, PQO, POQ, then RQB

In practice this problem might take the following form:

Given R_m, p, g.

Assume n (or F) and n' (or F').

From these values of n and n' compute all data required for a cross-over between straight main tracks. This will involve assuming value of D_1 and D_2 and computing a_1 and a_2 by § 150 or § 151.

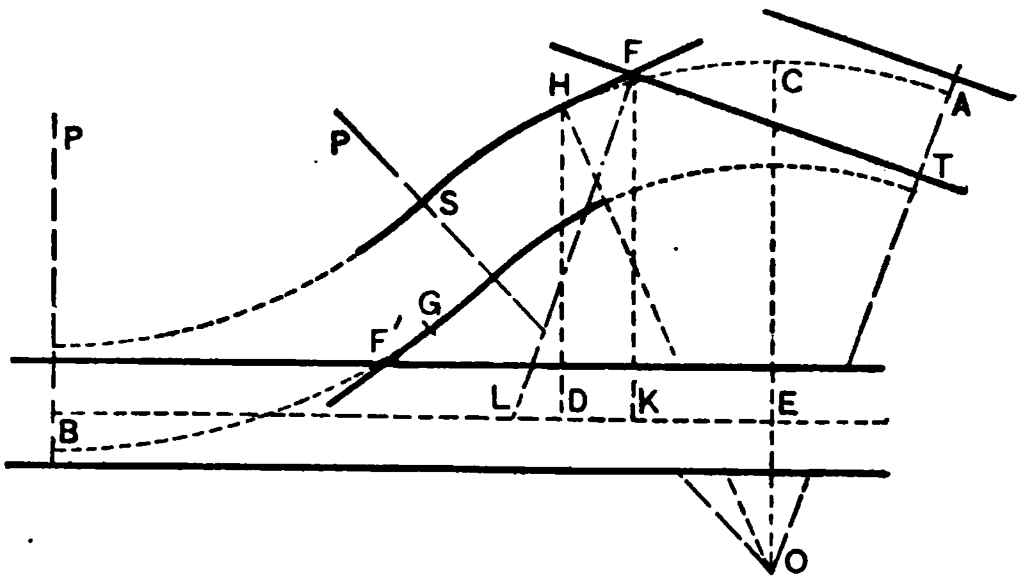
The values of a_1 and a_2 may be computed either for the case covered by (105) or by (107).

Then apply the bending process.

This will change the degrees of the turnout curves by the amount of D_m but the lengths of the turnout curves will remain unchanged (approx.) and the distances y_{a1} and y_{a2} obtained by (103) or (106) will also remain unchanged (approx.) as will also the values of a_1 and a_2.

170. Problem. *Given two main tracks not parallel. Also the unequal frog angles F, F'; also n, n', h, h', g; also the unequal radii R_1, R_2, of reversed curve connecting the two from heel to heel of frogs; also the position of one frog* F.

Required the angles BPS *and* SOH *of the reversed curve; also the position of point* B.



Let $\mathsf{OH} = R_1 + \frac{g}{2}$; $\mathsf{BP} = R_2 + \frac{g}{2}$

$\mathsf{HF} = h$

Set transit at theoretical point of given frog F.

Lay off FL perpendicular to TF.

Measure FL, also FLE.

Draw perpendiculars HD, FK, OC.

Let $I =$ angle between main tracks.

Then $\mathsf{FLE} = 90° - \mathsf{LFK} = 90° - I.$

$$\mathsf{HOC} = \mathsf{HOA} - \mathsf{COA} = F - I.$$

$$\mathsf{DK} = h \cos (F - I)$$

$$\mathsf{FK} = \mathsf{FL} \cos I; \quad \mathsf{LK} = \mathsf{FL} \sin I$$

$$\mathsf{HD} = \mathsf{FK} - h \sin (F - I)$$

$$\mathsf{CE} = \mathsf{HD} + \left(R_1 + \frac{g}{2}\right) \text{vers}\,(F - I)$$

$$= \mathsf{FL} \cos I - h \sin (F - I) + \left(R_1 + \frac{g}{2}\right) \text{vers}\,(F - I)$$

$$\mathsf{KE} = \left(R_1 + \frac{g}{2}\right) \sin (F - I) - h \cos (F - I)$$

Find by (107) a_1 at A and a_2 at B.

Then $p = \text{CE} - \frac{g}{2} - a_2$

$$\text{OP} = R_1 + R_2$$

Solve by (76) for BPS and COS.

$$\text{GPS} = \text{BPS} - F' \text{ ; SOH} = \text{COS} - (F - I)$$

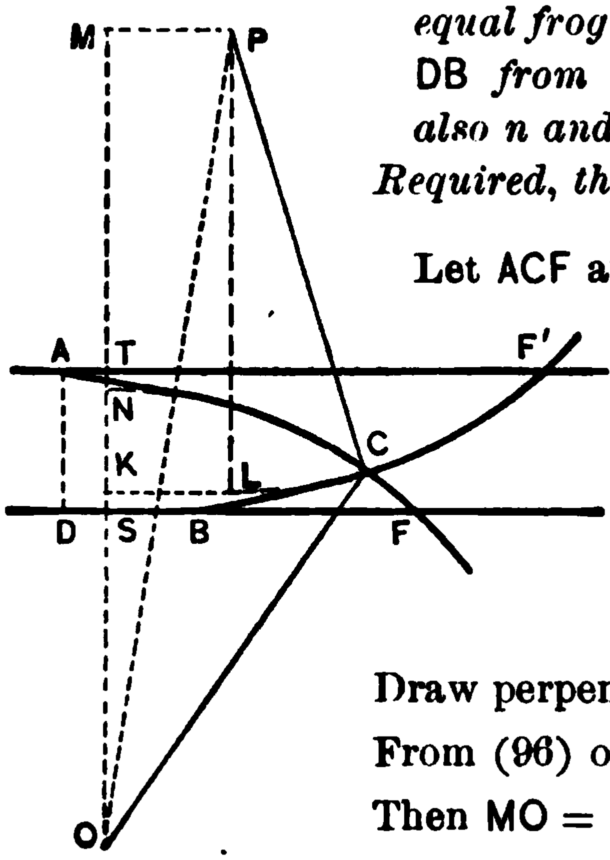
Also find $\text{BE} = (R_1 + R_2) \sin \text{BPS}$

$$\text{LB} = \text{BE} - \text{KE} - \text{LK}$$

From B, the point of frog F′ can readily be set in the field, its position having been established by (106) by computation.

171. Problem. *Given the R of either curve of a three-throw, or tandem split switch with switch rails of equal length; the equal frog angles F and F′; the distance* DB *from point to point of switch* $= d$*; also n and g.*

Required, the angle C of crotch frog at C.



Let ACF and BCF′ be rails of equal turnouts whose curves become parallel to DF at N and L.

$$\text{Let OC} = \text{PC} = R + \frac{g}{2}$$

Continue arcs to N and L ; join PO.

Draw perpendiculars AD, OM, PM, KL, PL.

From (96) or (96 *A*) find $a = \text{SK} = \text{TN}$.

Then $\text{MO} = \text{MK} + \text{NO} - \text{NK}$

$$= R + \frac{g}{2} + R + \frac{g}{2} - (g - 2a)$$

$$\text{MO} = 2R + 2a = 2(R + a)$$

$$\text{MP} = \text{KL} = \text{DB} = d.$$

In right triangle OMP find MOP and PO.

In isosceles triangle PCO, $\cos \text{COP} = \dfrac{\frac{1}{2}\text{PO}}{\text{OC}} = \dfrac{\frac{1}{2}\text{PO}}{R + \frac{g}{2}}$ (131)

$$2\,\text{COP} = C.$$

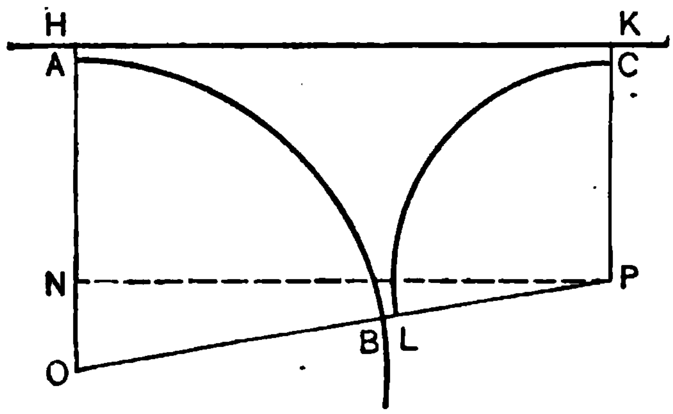
CHAPTER IX.

CONNECTING TRACKS AND CROSSINGS.

172. In many cases where a branch leaves a main track, an additional track is laid connecting the two. This is called a "*Y*" track, and the combination of tracks is called a "*Y.*"

173. Problem. *Given a straight main track* HK, *also the P.C. and radius R_1 of curve beyond the frog. Also radius R_2 of "Y" track between the frogs. Also select practicable values of F_1, F_2, F_3.*

Required the distance HK *from P.C. of turnout to P.C. of "Y" track; also the central angles of turnout and of "Y" track to the point of junction.*



Let HK be the given straight main track.

AB the turnout.

CL the "*Y*" track.

Draw perpendicular NP.

Let
$$\text{HK} = \text{NP} = l$$
$$\text{AOB} = I_t$$
$$\text{CPL} = I_y = 180^\circ - I_t$$

Find $\text{AH} = a_1$; $\text{KC} = a_2$; $\text{BL} = a_3$ by (107) p. 88.

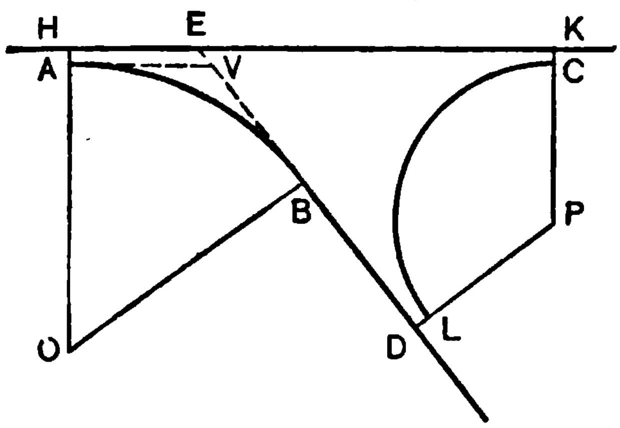
Then $\cos \text{AOB} = \dfrac{\text{ON}}{\text{OP}}$

$$\cos I_t = \frac{\text{HO} - \text{KP}}{\text{OB} + \text{BL} + \text{LP}} = \frac{R_1 + a_1 - R_2 - a_2}{R_1 + R_2 + a_3} \qquad (132)$$

$$l = (R_1 + R_2 + a_3) \sin I_t \qquad (133)$$

174. Problem. *Given a straight main track* HEK, *also the P.C., radius beyond the frog* OB, *and central angle* AOB, *of turnout curve connecting with a second tangent* BD ; *also the radius* PC *of "Y" track. Also select practicable values of F_1, F_2.*

Required the distance HK *from P.C. of turnout to P.C. of "Y" track; also distance* BD *from P.T. of turnout curve to P.T. of "Y" track.*



Let HEK be the given main track; ABD the turnout; CL the "Y" track.

Let $AO = R_1$; $CP = R_2$

$HK = AC = l$; $BD = m$

$HA = a_1$; $KC = a_2$

$AOB = I_1$; $DL = a_2$

$CPL = I_2$

Produce DB to E.

Draw parallel AV. Find a_1 and a_2 by (107).

$$\text{Then } BD = ED - (VB + EV)$$

$$= KP \tan \tfrac{1}{2} CPL - \left(AO \tan \tfrac{1}{2} AOB + \frac{HA}{\sin KEV}\right)$$

$$= (R_2 + a_2) \tan \tfrac{1}{2} I_2 - \left(R_1 \tan \tfrac{1}{2} I_1 + \frac{a_1}{\sin I_1}\right)$$

$$m = (R_2 + a_2) \cot \tfrac{1}{2} I_1 - \left(R_1 \tan \tfrac{1}{2} I_1 + \frac{a_1}{\sin I_1}\right) \quad (134)$$

$$\text{also} \quad HK = EK + EH$$

$$l = (R_2 + a_2) \cot \tfrac{1}{2} I_1 + \left(R_1 \tan \tfrac{1}{2} I_1 - \frac{a_1}{\tan I_1}\right) \quad (135)$$

In case different frogs are used near D and K so that KC and DL are not equal, the formulas will be modified.

Let $KC = a_s$ the smaller value

$DL = a_l$ the larger value.

Following the method of § 191, p. 122 :

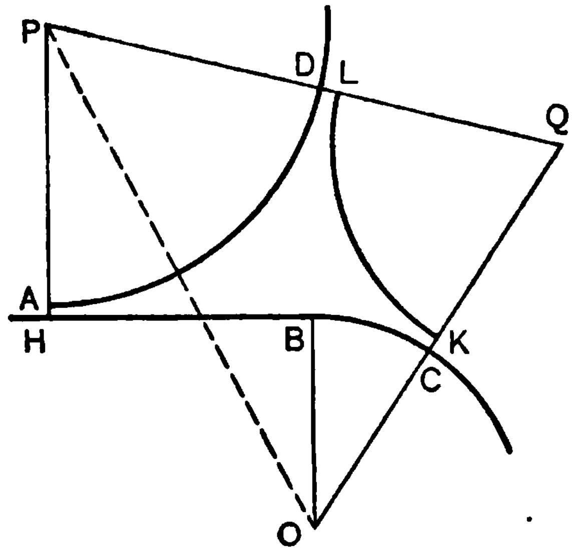
$$EK = (R_2 + a_s) \cot \tfrac{1}{2} I_1 + \frac{a_l - a_s}{\sin I_1}$$

$$ED = (R_2 + a_s) \cot \tfrac{1}{2} I_1 + \frac{a_l - a_s}{\tan I_1}.$$

175. Problem. In the accompanying sketch where

HBC = main track. AD = turnout.

LK = "Y" track.



Given $HB = l$; $OB = R_m$

$AP = R_1$; $LQ = R_2$.

Select F_1; F_2; F_3.

Required the points D and C.

Find $AH = a_1$; $CK = a_2$

$DL \doteq a_3$ by (107)

then $PH = R_1 + a_1$

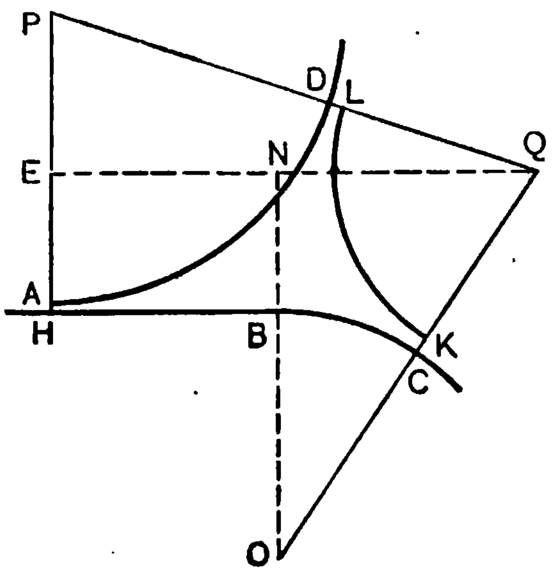
$CQ = R_2 + a_2$

$DQ = R_2 + a_3$

Considering	PH + BO as base of a right triangle
	HB as its altitude
Find	OPH, and PO the hypotenuse
Find also	$PQ = R_1 + R_2 + a_3$, $QO = R_m + R_2 + a_2$
then	POQ, OPQ, PQO
then	BOC, APQ

D and C will then be easily determined.

In the figure where HBC is the main track and LK is the turnout, AD the "Y" track.



Given $OB = R_m$; $KQ = R_2$

$AP = R_1$; $BOC = O$

Select F_1; F_2; F_3

Required the points A and D.

Find a_1, a_2, a_3 by (107)

Find QN, ON, then EP

also EQP, EQ

then EN = HB

and PQO = EQP + OQN

PQO determines position of L or D

EPQ determines length AD and EN = HB fixes H or A

In finding CK and DL in the foregoing problems of § 173 and § 175 the values of a_2 and a_3 are found from (107) after applying the "bending process."

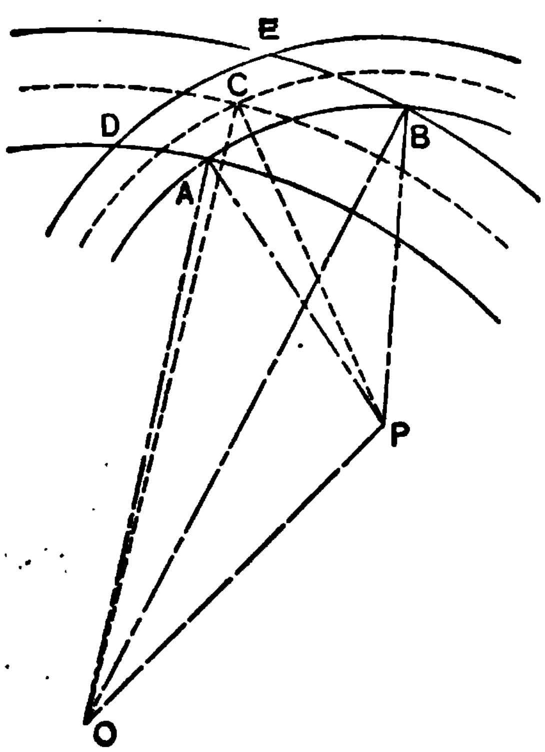
Example.

If curve AD is a 3° curve and Y track a 7° curve, then the offset DL $= a_3$ will be calculated just as it would be to connect a tangent with a 10° curve ($10° = 7° + 3°$), the same number or angle of frog being used.

Similarly the offset CK $= a_2$ will be the same as that for a tangent and a curve whose degree is the sum of the degrees of curves LK and BC.

176. Problem. *Given the radii, R_1, R_2, of two curves crossing at* C*; also the angle at crossing* C*; also g and g'.*

Required, the frog angles at A, B, D, E*; also the lengths on the curves of the rails* AB, BE, DE, AD.



Having given OC $= R_1$; OCP $= C$; and PC $= R_2$; find in triangle OCP, the line OP.

Having given OA $= R_1 - \frac{g}{2}$

also OP; and PA $= R_2 - \frac{g'}{2}$

find in triangle OPA, angles APO, AOP, and OAP $= A$.

Having given OB $= R_1 + \frac{g}{2}$

also OP; and PB $= R_2 - \frac{g'}{2}$

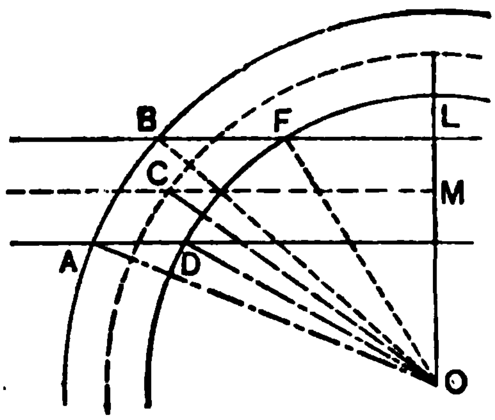
find in triangle OPB, angles BPO, BOP, and OBP $= B$.

Then APB = BPO − APO, and AB $= \left(R_2 - \frac{g'}{2}\right)$angle APB.

The frog angles at D and E, and the lengths AD, DE, EB, may be calculated in similar fashion.

177. Problem. *Given a curve crossing a tangent, R, g, g', and angle C between tangent and curve.*
Required frog angles at A, B, F, D.

Draw AO, BO, CO, FO, DO; also, MO perpendicular to CM.



Then $\quad \text{MO} = R \cos C$

$$\cos \text{MOA} = \cos A = \frac{\text{MO} - \frac{g'}{2}}{R + \frac{g}{2}} \qquad (136)$$

$$\cos \text{MOD} = \cos D = \frac{\text{MO} - \frac{g'}{2}}{R - \frac{g}{2}} \qquad (137)$$

$$\cos B = \frac{\text{MO} + \frac{g'}{2}}{R + \frac{g}{2}} \quad (138) \qquad \cos F = \frac{\text{MO} + \frac{g'}{2}}{R - \frac{g}{2}} \quad (139)$$

$$\text{DOF} = \text{MOD} - \text{MOF} = D - F$$

The rail length $\text{DF} = \left(R - \frac{g}{2}\right)$ angle DOF; and BF = BL − FL.

Example. *Given* $C = 32° 28'$; $D = 8°$ $g = 3$; $g' = 4' 8\frac{1}{2}''$.
Required angle D and distance DF.

R_8 log = 2.855385
32° 28′ cos = 9.926190
MO = 604.748 log = 2.781575
$\frac{1}{2} g'$ = 2.354
607.102 log = 2.783261
OF = 715.28 log = 2.854476
31° 55′ 23″ cos = 9.928785

Table XX. 42′ = 0.0122173
21″ = 0.0001018
0.0123191

R_8 = 716.78
$\frac{1}{2} g$ = 1.50
OD = OF = 715.28

MO = 604.748
$\frac{1}{2} g'$ = 2.354
602.394

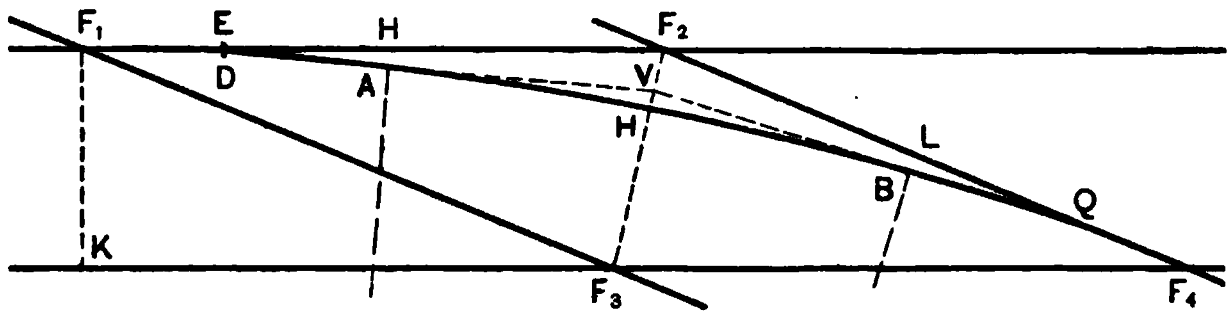
602.394 log = 2.779881
715.28 log = 2.854476
32° 37′ 44″ cos 9.925405
31° 55′ 23″
DOF = 0° 42′ 21″

2.854476 = log 715.28 = $R - \frac{g}{2}$
log = 8.090579
0.945055 log = 8.812 = DF.

178. When two tracks cross at a small angle, they are often connected by a "slip switch," in which the outer rail lies entirely within the limits of the crossing and is composed of two switch rails and a connecting curve as shown in the figure below.

Problem. *Given for a crossing of two tracks the angle of crossing frog F, also n, b, g; also clearance m from actual point of frog to point of split switch; also l and t.*

Required, lengths along rail between frog points; also radius R of curve for a slip switch.



Let $DA = QB = l =$ length of switch rail

$HA = LB = t$

$F_1E = F_4Q = m =$ clearance required

Then $bn =$ distance between theoretical and actual points of frogs F_1 and F_4; in frogs F_2 and F_3 theoretical and actual points coincide.

$$F_1F_3 = \frac{g}{\sin F} + bn = F_1F_2 = F_3F_4 = F_2F_4$$

In the slip switch, produce the gauge lines DA and QB to V on the line F_2F_3. Although the point of switch has a thickness ED of about a quarter of an inch, no appreciable error results if DV be calculated assuming DF_2V to be a triangle, in which

$$F_2DV = S;\ DF_2V = 90^\circ - \frac{F}{2};\ F_2D = F_1F_2 - m$$

Then $$AV = DV - l$$

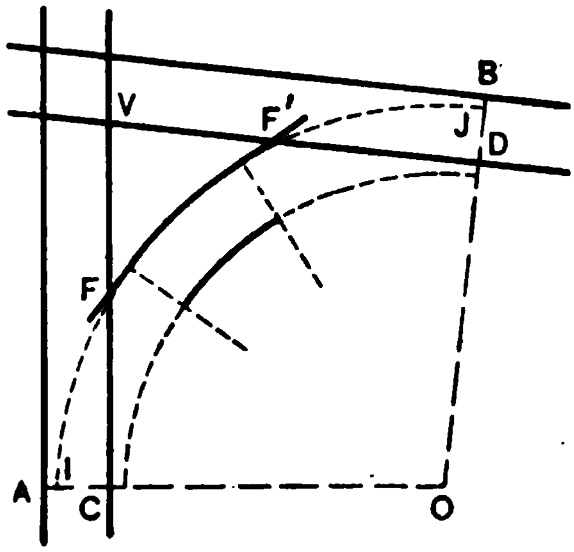
$$R + \frac{g}{2} = \frac{AV}{\tan \frac{1}{2}(F - 2S)}$$

Middle ordinate for chord $AB = \left(R + \frac{g}{2}\right) \text{vers } \frac{1}{2}(F - 2S)$

$$\text{Arc } AB = \left(R + \frac{g}{2}\right) \text{ angle } (F - 2S)$$

179. Problem. *Given two main tracks crossing at a given angle I; the radius R of curve connecting the two, and extending from heel of frog to heel of equal frog.*

Required the distances VF = VF′ *between actual points of frogs.*



Produce given curve to I and J where it is parallel to given main tracks.

Find by (107) $a = a'$.

$$\mathrm{OC} = R + a - \frac{g}{2}$$

$$\mathrm{CV} = \left(R + a - \frac{g}{2}\right)\tan \tfrac{1}{2} I$$

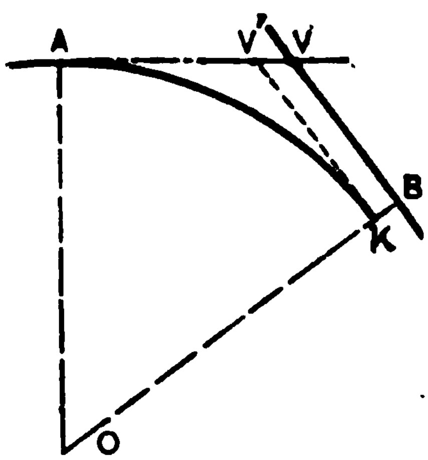
$$\mathrm{CF} = y_a \qquad \text{from (106)}$$

$$\mathrm{VF} = \mathrm{CV} - \mathrm{CF} = \mathrm{VF'}$$

If the angle at V is at all sharp, allowance should be made for the difference between the theoretical and actual point of the frog at V.

180. Problem. *Given a straight main track* VB *and the straight line* AV *of a branch track, intersecting it at a given point* V, *and at a given angle I; also radius R of turnout curve to connect branch line and heel of frog; also F, n, h, b, g.*

Required in figure, VA, VB; *also position of point of frog.*



Find a by (107).

$$\mathrm{AV} = \mathrm{AV'} + \mathrm{VV'}$$

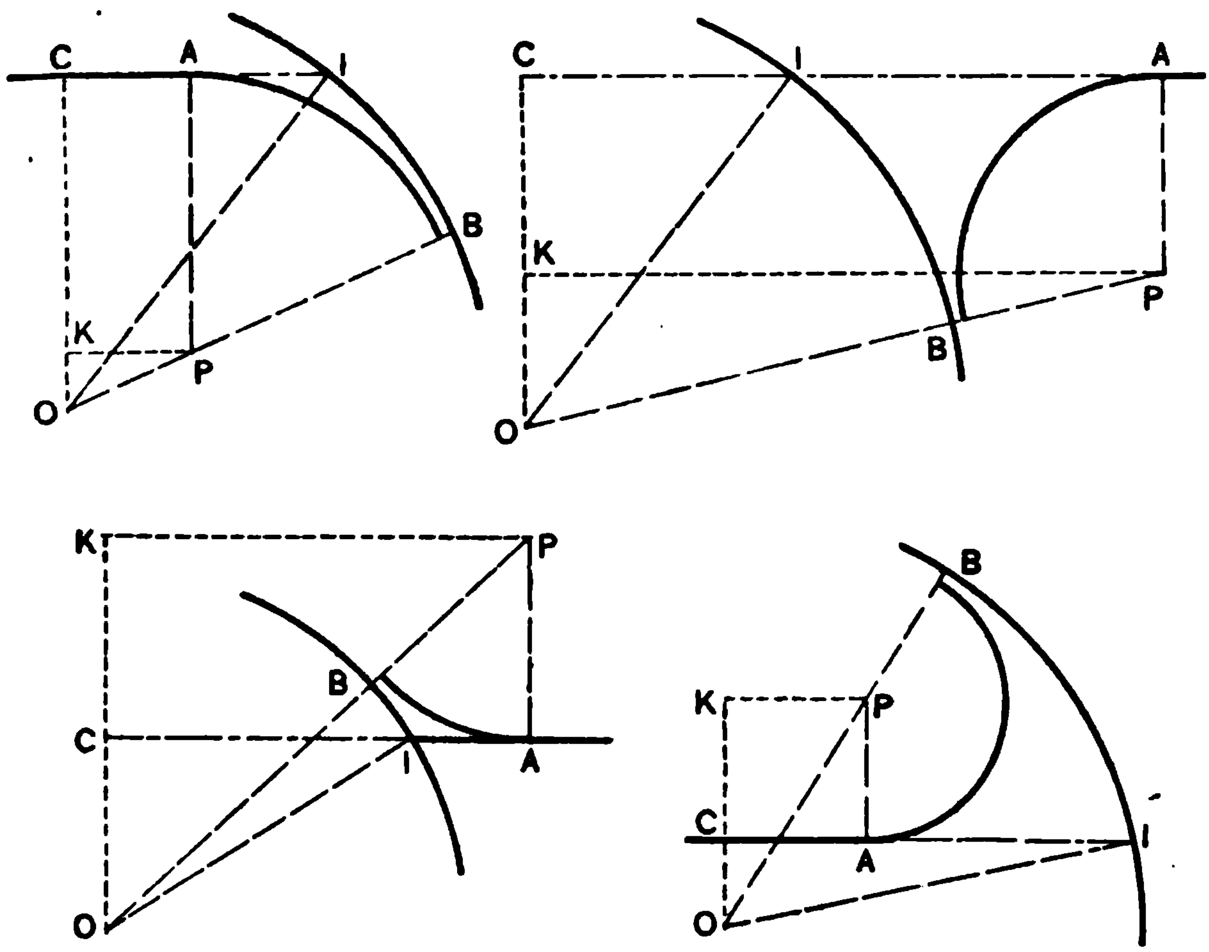
$$= R \tan \tfrac{1}{2} I + \frac{a}{\sin I}$$

$$\mathrm{VB} = R \tan \tfrac{1}{2} I - \frac{a}{\tan I}.$$

Find F from B by fieldwork or computation, using (106).

181. Problem. *Given a curved main track* IB *of radius* R_m *a straight branch track* AI *intersecting at a given angle* I; *also radius* R_t *of turnout curve from heel of frog to branch line; also* F, n, h, b, g.

Required in the figure, IA, IOB



Let O be the center of curve of main line

P be the center of curve of turnout

Draw perpendiculars PA, OC, PK

Find a by (107)

$\text{IOC} = I$

$\text{OC} = R_m \cos I$; $\text{IC} = R_m \sin I$

$\text{OP} = R_m \pm (R_t + a)$

$\text{KO} = \text{OC} \pm R_t$

$\frac{\text{KO}}{\text{OP}} = \cos \text{KOP}$; $\text{KP} = \text{OP} \sin \text{KOP}$

$\text{IA} = \text{IC} - \text{KP}$; or $= \text{KP} - \text{IC}$; $\text{IOB} = \text{KOB} - I$ or $= I - \text{KOB}$

IOB determines position of B

Find position of frog point by (106)

182. Problem. *Given a straight main track* IBC *and a curved branch track of radius* R_b *intersecting at an angle* I*; also radius* R_t *of turnout curve from heel of frog to branch line; also* F, n, h, b, g.

Required in the figure, IB, IOA

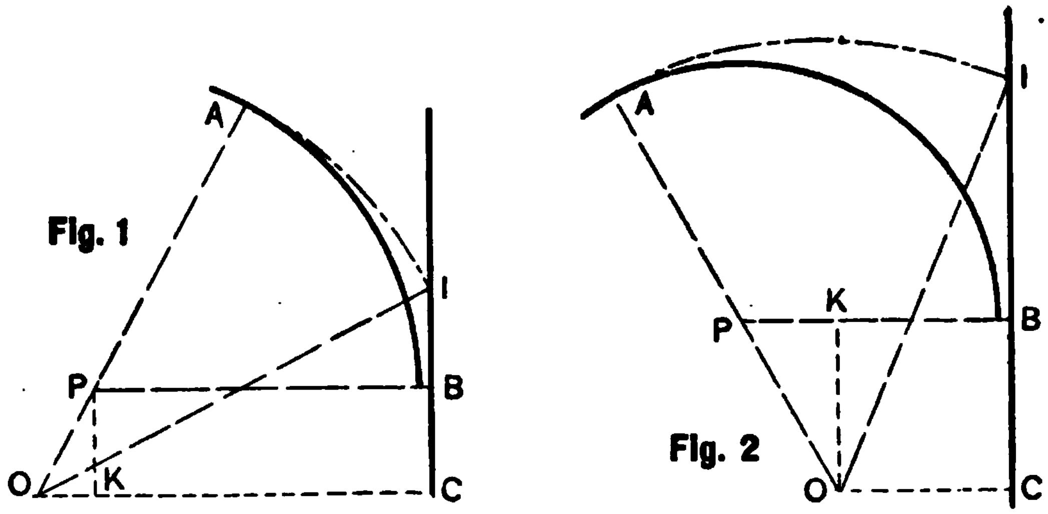


Fig. 1 Fig. 2

Let O be the center of curve of branch line

P be the center of curve of turnout

Draw perpendiculars PB, OC, PK

Find a by (107)

$$\text{IOC} = I$$
$$\text{OC} = R_b \cos I; \quad \text{IC} = R_b \sin I$$
$$\text{OP} = R_b - R_t$$

In Figure 1

$$\text{KO} = \text{OC} - (R_t + a)$$
$$\frac{\text{KO}}{\text{OP}} = \cos \text{POK}; \quad \text{PK} = \text{OP} \sin \text{POK}$$
$$\text{IB} = \text{IC} - \text{PK}; \quad \text{IOA} = \text{POK} - I$$

In Figure 2

$$\text{PK} = (R_t + a) - \text{OC}$$
$$\frac{\text{PK}}{\text{OP}} = \sin \text{POK}; \quad \text{KO} = \text{OP} \cos \text{POK}$$
$$\text{IB} = \text{IC} - \text{KO}; \quad \text{IOA} = \text{POK} + 90° - I$$

Other cases will occur requiring figures different from those shown here · some of them will be suggested by the figures in § 181.

183. Problem. *Given a straight track and a curved track of radius R_m intersecting at a given angle I; also radius R_t of turnout curve from heel of frog to heel of frog; also F, n, h, b, g.*
Required in the figure, IOA, IB

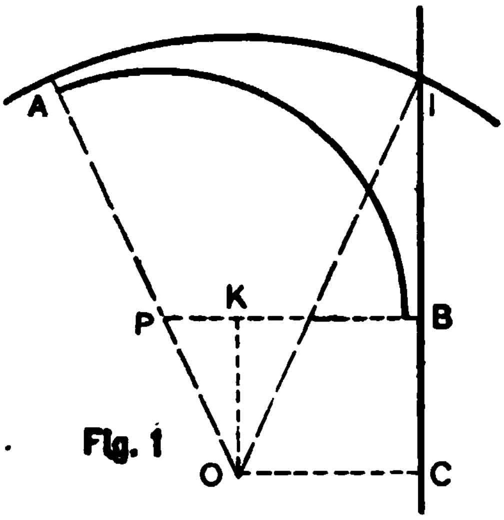


Fig. 1

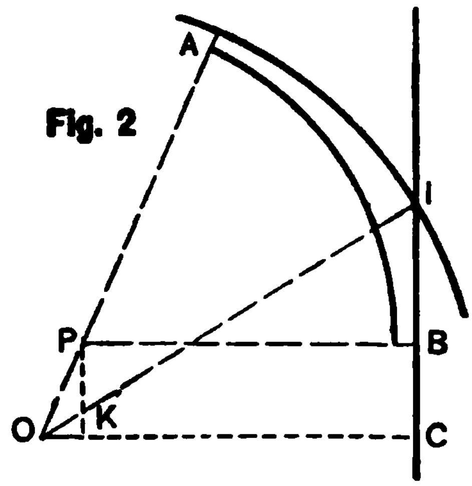


Fig. 2

Let O be the center of curve of main track
P be the center of curve of turnout
Draw perpendiculars PB, OC, OK, or PK
Find a_1 and a_2 at A and B by (107)

$$\text{IOC} = I$$
$$\text{OC} = R_m \cos I; \ \text{IC} = R_m \sin I$$
$$\text{OP} = R_m - (R_t + a_1)$$

In Figure 1

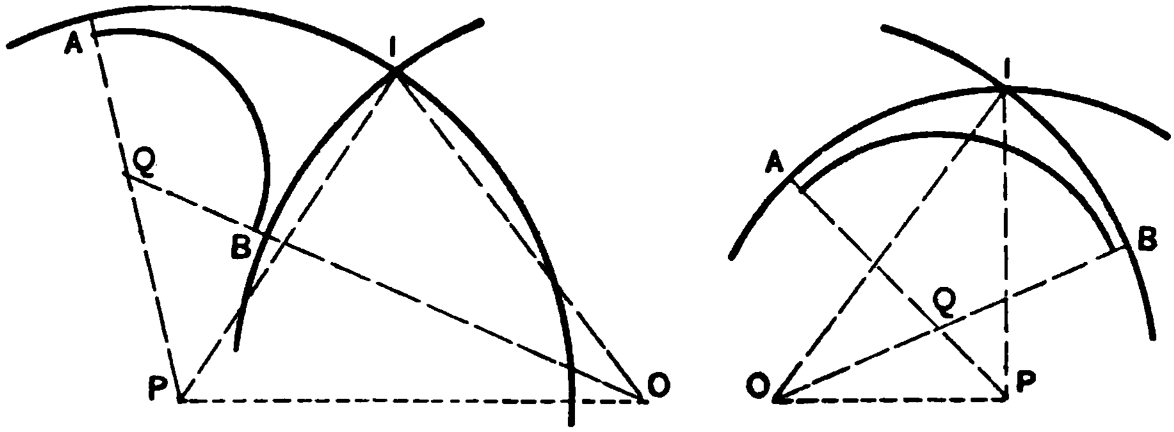
$$\text{PK} = R_t + a_2 - \text{OC}$$
$$\frac{\text{PK}}{\text{OP}} = \sin \text{POK}; \quad \text{KO} = \text{OP} \cos \text{POK}$$
$$\text{IB} = \text{IC} - \text{KO}; \quad \text{IOA} = \text{POK} + 90° - I$$

In Figure 2

$$\text{KO} = \text{OC} - (R_t + a_2)$$
$$\frac{\text{KO}}{\text{OP}} = \cos \text{POK}; \quad \text{PK} = \text{OP} \sin \text{POK}$$
$$\text{IB} = \text{IC} - \text{PK}; \quad \text{IOA} = \text{POK} - I$$

Other cases will occur requiring figures different from those shown here; some of them will be suggested by the figures in § 181.

184. Problem. *Given two curved lines of track of radii R_1 R_2 crossing each other, intersecting at an angle I; also the radius R_t of turnout from heel to heel of frog; also F, n, h, b, g. Required in the figure,* API, IOB



Let O and P be centers of main tracks
Q be center of turnout

$$OIP = I$$

Find a_1 at A, and a_2 at B by (107)

In triangle IOP, $IO = R_2$; $IP = R_1$; $OIP = I$

Solve for OP, IOP, IPO

In triangle OQP, $QP = R_1 - (R_t + a_1)$; $QO = R_2 + (R_t + a_2)$; OP computed

Solve for QOP, QPO, OQP

From QPO and IPO, find API

From IOP and QOP, find IOB

CHAPTER X.

SPIRAL EASEMENT CURVE.

185. Upon tangent, track ought properly to be level across; upon circular curves, the outer rail should be elevated in accordance with the formula

$$e = \frac{gv^2}{32.2\,R}$$

in which e = elevation in feet
g = gauge of track
v = velocity in feet per second
R = radius of curve in feet

In passing around a curve, the centrifugal force $c = \dfrac{Wv^2}{32.2\,R}$

It is desirable for railroad trains that the centrifugal force should be neutralized by an equal and opposite force, and for this purpose, the outer rail of track is elevated above the inner. Any pair of wheels, therefore, rests upon an incline, and the weight W resting on this incline may be resolved into two components, one perpendicular to the incline, the other parallel to the incline, and towards the center of the curve.

The component p parallel to the incline will be $p = \dfrac{We}{g}$

It will be a very close approximation to assume that c acts parallel to the incline (instead of horizontally). The centrifugal force will be balanced (approx.) if we make

$$p = c \text{ or } \frac{We}{g} = \frac{Wv^2}{32.2\,R}$$

whence

$$e = \frac{gv^2}{32.2\,R} \qquad (140)$$

In passing directly from tangent to circular curve, there is a point (at *P.C.*) where two requirements conflict; the track cannot be level across and at the same time have the outer rail elevated. It has been the custom to elevate the outer rail on the tangent for perhaps 100 feet back from the *P.C.* This is unsatisfactory. It has therefore become the best practice to introduce a curve of varying radius, in order to allow the train to pass gradually from the tangent to the circular curve.

186. The transition will be most satisfactorily accomplished when the elevation e increases uniformly with the distance l from the *T.S.* (point of spiral) where the spiral easement curve leaves the tangent; then $\frac{e}{l}$ is a constant

$$\text{or } \frac{gv^2}{32.2\,Rl} = A \text{ (a constant) or } Rl = \frac{gv^2}{32.2\,A}$$

Since g, v, A are constants, $Rl = C$ (a constant)

Then $$Rl = R_c l_c \text{ and } R = \frac{R_c l_c}{l}. \qquad (141)$$

also $$\frac{l}{D} = \frac{l_c}{D_c} \text{ or } \frac{D}{D_c} = \frac{l}{l_c} \text{ (approx.)} \qquad (141\,A)$$

where R_c = radius of circle

D_c = degree of circular curve

l_c = total length of spiral in feet.

Let s = the "Spiral Angle" or total inclination of curve to tangent at any point.

s_c = spiral angle where spiral joins circle.

Then $$Rds = dl \text{ or } ds = \frac{dl}{R}$$

from (141) $$= \frac{ldl}{R_c l_c}$$

$$s = \frac{l^2}{2\,R_c l_c} \qquad (142)$$

Again $dx = dl \sin s$ and $dy = dl \cos s$

All values of s will generally be small, and we may assume

$$\sin s = s \qquad \text{and} \qquad \cos s = 1$$

then $\quad dx = s\,dl \qquad\qquad dy = dl$

$$= \frac{l^2\,dl}{2\,R_c l_c} = \frac{y^2\,dy}{2\,R_c l_c} \qquad\qquad y = l$$

Integrating, $\quad x = \dfrac{y^3}{6\,R_c l_c} \qquad (143)$

which is the equation of the "Cubic Parabola," a curve frequently used as an easement curve.

If, however, the approximation $\cos s = 1$ be not used, the resulting curve will be more nearly correct than is the Cubic Parabola. In this case $\quad \sin s = s$

$$dx = s\,dl = \frac{l^2\,dl}{2\,R_c l_c}$$

Integrating, $\quad x = \dfrac{l^3}{6\,R_c l_c} \qquad (144)$

The resulting curve we may call, for the lack of a better name, the "Cubic Spiral" Easement Curve.

The Cubic Parabola is well adapted to laying out curves by "offsets from the tangent." Modern railroad practice favors "deflection angles" as the method of work wherever practicable. In the case of an easement curve the longitudinal measurements are most conveniently made as chords along the curve, so that $x = \dfrac{l^3}{6\,R_c l_c}$ represents a curve more convenient for use than is $x = \dfrac{y^3}{6\,R l_c}$ as well as more nearly correct. Evidently the properties of the two curves will be very similar.

The following notation in connection with spirals has been adopted by the Am. Ry. Eng. Ass'n. For the point of change

from tangent to spiral, *T.S.*
from spiral to circular curve, *S.C.*
from circular curve to spiral, *C.S.*
from spiral to tangent, *S.T.*

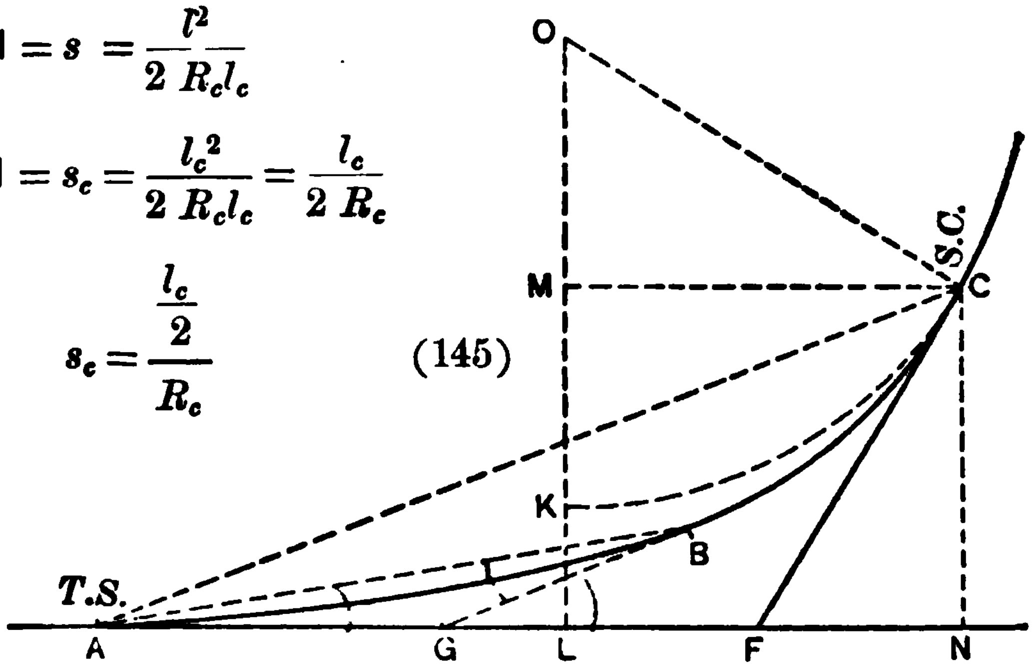
This notation will be adopted here.

187. *Given, in a Cubic Spiral, l, l_c, R_c*
Required s, s_c, and "total deflection angles" i, i_c

(142) $\text{BGN} = s = \dfrac{l^2}{2\,R_c l_c}$

and $\text{CFN} = s_c = \dfrac{l_c^2}{2\,R_c l_c} = \dfrac{l_c}{2\,R_c}$

$$s_c = \frac{\frac{l_c}{2}}{R_c} \qquad (145)$$



This (145) is the expression (in the form of length of arc for radius 1) for the central angle of the connecting circular curve for a length of one-half the length of spiral. In another form it is

$$s_c = \frac{l_c D_c}{200} \quad (l_c \text{ in feet and } s_c \text{ in degrees}) \qquad (145\,A)$$

If the circular curve be produced back from C to K where it becomes parallel to AN, its length in feet will be $\frac{l_c}{2}$ since KOC = CFN = s_c.

Also $\text{AL} = q = \frac{l_c}{2}$ (approx.) (145 *B*)

Again for any point B on the spiral

$$\sin \text{BAN} = \sin i = \frac{x}{l} \text{ (approx.)}$$

$$i = \frac{x}{l} \text{ (approx.)} = \frac{l^3}{6\,R_c l_c l} = \frac{l^2}{6\,R_c l_c}$$

But $\quad s = \dfrac{l^2}{2\,R_c l_c}$ from (142)

Whence $\quad i = \dfrac{s}{3}$ and $i_c = \dfrac{s_c}{3}$ (146)

Also $\quad i : i_c = l^2 : l_c^2$; or $i = i_c\left(\dfrac{l}{l_c}\right)^2$ (146 *A*)

Also the back deflection ABG = BGN − BAN

$$= s - i = 3\,i - i = 2\,i$$

Also $\quad \text{ACF} = 2\,i_c$ (146 *B*)

It will be observed that the Cubic Spiral has the following properties (some slightly approximate):

(*a*) The degree of curve varies directly with the length from the *T.S.* (141 *A*)

(*b*) The deflection angles vary as the squares of the lengths from the *T.S.* (146 *A*)

(*c*) The offsets from the tangent vary as the cubes of the lengths from the *T.S.* (144)

(*d*) The "spiral angle" at the point where the spiral joins the circular curve is equal to the central angle of a circular curve of the same degree and of a length one-half that of the spiral. (145)

(*e*) The deflection angle to any point on the spiral is one-third the spiral angle at that point. (146)

188. *Given l, l_c, R_c. Required y and y_c.*

From (30) the excess of hypotenuse over base

$$e = c - a = \frac{h^2}{2c}$$

Then in the Cubic Spiral, at any point on the spiral, let the excess $de = dl - dy$

from (30) $$de = \frac{dx^2}{2\,dl} = \frac{l^4\,dl^2}{2 \times 4\,R_c^2 l_c^2 dl} = \frac{l^4\,dl}{8\,R_c^2 l_c^2}$$

integrating, $$e = l - y = \frac{l^5}{40\,R_c^2 l_c^2}$$

$$y = l - \frac{l^5}{40\,R_c^2 l_c^2} \qquad (147)$$

$$y_c = l_c - \frac{l_c^5}{40\,R_c^2 l_c^2} = l_c - \frac{l_c^3}{40\,R_c^2} \qquad (147\,A)$$

189. *Given R_c, y_c, x_c, s_c. Required* $AL = q$ and $LK = p$.

$CN = x_c$ and $AN = y_c$

$AL = AN - OC \sin COK$ or $q = y_c - R_c \sin s_c$ (148)

$LK = CN - OC \text{ vers } COK$ $p = x_c - R_c \text{ vers } s_c$ (148 *A*)

Tables have been computed for the Cubic Spiral described above. These have been abandoned in favor of the spiral adopted by the Am. Ry. Eng. Ass'n, and new tables arranged for this spiral which is described in the following section.

190. In the Cubic Spiral, the lengths have been considered as measured along the curve itself; but measurements in the field are necessarily taken by chords. This is recognized in defining the degree of a simple curve § 39 as the angle at the center subtended by a *chord* of 100 ft. Consistent with this, in the Am. Ry. Eng. Ass'n Spiral, the length of spiral is measured by *ten equal chords*, so that the theoretical curve is brought into harmony with field practice. This spiral will be referred to here as the A. R. E. A. Spiral, and adopted in place of the Cubic Spiral. The two curves substantially coincide up to the point where $s_c = 15°$, and the discussion of the Cubic Spiral applies in a general way to the A. R. E. A. Spiral also. Beyond $s_c = 15°$ the A. R. E. A. Spiral has its tables computed substantially without approximations, making it a very perfect and convenient transition curve even for sharp curves on street railways.

The A. R. E. A. Spiral retains the following features characteristic of the Cubic Spiral:

(*a*) The degree of curve varies directly with the length from the *T.S.*

$$\frac{D}{D_c} = \frac{l}{l_c} \tag{141 A}$$

(*b*) The deflection angles vary as the squares of the lengths from the *T.S.*

$$\frac{i}{i_c} = \left(\frac{l}{l_c}\right)^2 \tag{146 A}$$

(*d*) The spiral angle at the point where the spiral joins the circular curve is equal to the central angle of a circular curve of the same degree and of a length one-half that of the spiral.

$$s_c = \frac{l_c D_c}{200} \tag{145 A}$$

(*e*) For practical purposes the deflection angle to any point on the spiral is one-third the spiral angle at that point (up to a value of $s_c = 15°$),

or
$$i = \frac{s}{3} \tag{146}$$

Beyond 15° and up to 45° for values of s_c, correct values have been computed by the Am. Ry. Eng. Ass'n and the following empirical formula is found to apply:

$$i = \frac{s}{3} - 0.00297\, s \text{ (seconds)}$$

With the A.R.E.A. Spiral, the angle made with the tangent at the *T.S.* by the first chord is taken as

$$\alpha_1 = \frac{s_c}{300}$$

No appreciable error is found to result if the angles made by successive chords with this tangent are taken as exact multiples of α_1 as follows:

1, 7, 19, 37, 61, 91, 127, 169, 217, 271

It is evident that these values of α_1, α_2, etc. depend upon s_c and are independent of the length of chord used.

For computing values of x_c, y_c the method of "offsets from the tangent" § 66 is adopted and co-ordinates x, y, at each chord point are found by using

$$\frac{l_c}{10}\sin\alpha_1,\ \frac{l_c}{10}\cos\alpha_1;\ \frac{l_c}{10}\sin\alpha_2,\ \frac{l_c}{10}\cos\alpha_2, \text{ etc.}$$

For a given value of s_c the final co-ordinates $x_c y_c$ will be directly proportional to l_c, so that $\frac{x_c}{l_c} \cdot \frac{y_c}{l_c}$ will be constants of a given value of s_c. It will be true of the long chord C from *T.S.* to *S.C.* that $\frac{C}{l_c}$ will also be a constant.

A condensed table of values of $\frac{x_c}{l_c}$, $\frac{y_c}{l_c}$, $\frac{C}{l_c}$ is given in Table VII, B; for values of s_c differing by 0° 30′.

This table will have occasional rather than frequent use; intermediate values may be interpolated with sufficient precision for ordinary cases; the labor of interpolating will not be burdensome.

From these values of x_c and y_c, determined as above, values of i_c have been computed for successive values of s_c up to 45° and these are tabulated in Table VII. All of the computations mentioned above have been made by the Am. Ry. Eng. Ass'n.

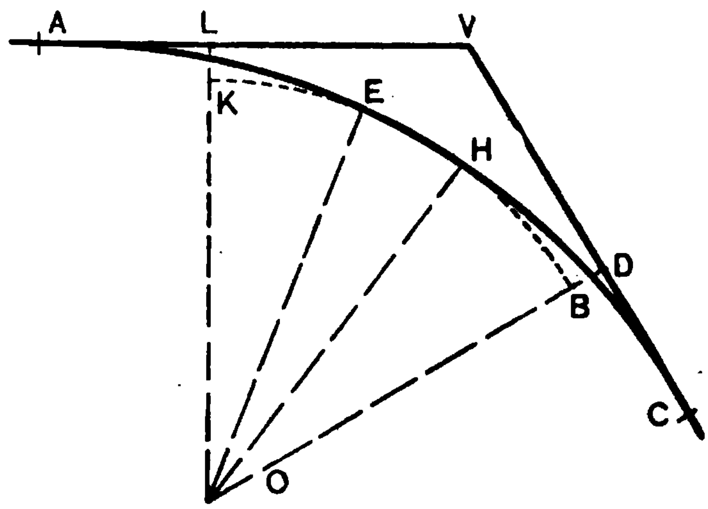
For convenient use in the field the deflection angle to each chord point is necessary, and the author has computed these for successive values of s_c and tabulated them in Table VII.

The deflection angles are constant for a given value of s_c and may be used for this value of s_c whatever the length of spiral, provided the chord length is made one-tenth the length of spiral.

Values of p and q have been computed by the author by (148, and (148 *A*) for various degrees of curve, and for various lengths of spiral, and these are found in Table VI which gives for each degree and half degree of curve, a series of lengths of spiral, and for each length, values of s_c, p, q, x_c, y_c, C.

191. Problem. *Given I, l_c, and R_c* or *D_c.*

Required the Tangent Distance T_s.



Find q and p by § 189 or by Table VI or by Table VII *B*.

(*a*) When the spirals at both ends of the circular curve are alike.

Let $AL=q$ and $LK=p$

$AV=AL+LV$

$=AL+OL \tan \frac{1}{2} LOD$

$T_s=q+(R_c+p) \tan \frac{1}{2} I$

$$T_s=q+T_c+p \tan \frac{1}{2} I \qquad (149)$$

where T_c is tangent distance for circular curve alone, for the given value of I.

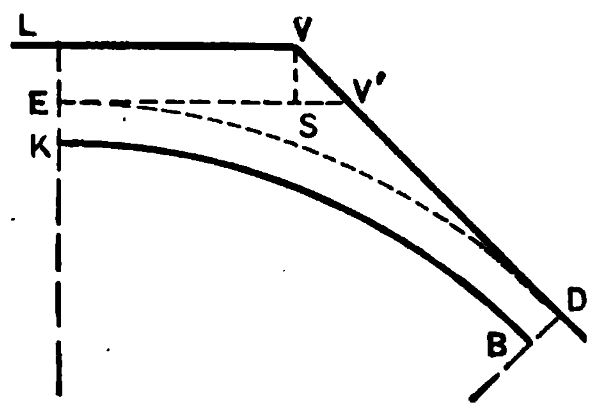
(*b*) When different spirals are used at the ends, separate values must be found for LV and DV.

Let $LK=p_l$

$BD=p_s$

Draw arc DE.

Also perpendiculars EV′, VS.



$$VS=p_l-p_s$$

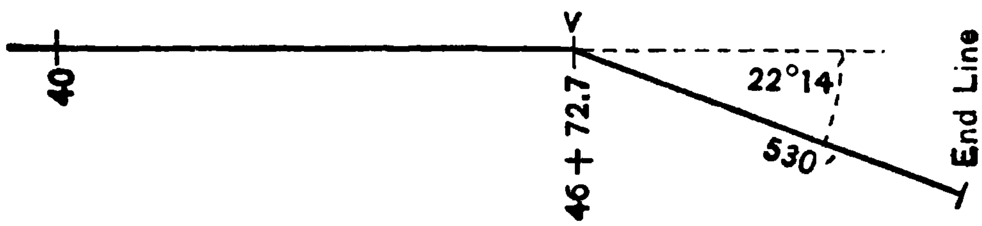
$$VV'=\frac{p_l-p_s}{\sin I}$$

$$SV'=\frac{p_l-p_s}{\tan I}$$

$$LV=(R+p_s)\tan \tfrac{1}{2} I-\frac{p_l-p_s}{\tan I} \qquad (149\ A)$$

$$DV=(R+p_s)\tan \tfrac{1}{2} I+\frac{p_l-p_s}{\sin I} \qquad (149\ B)$$

Example. *Given a line as shown in sketch.*
Required to connect the tangents by a 4° curve with a spiral 180 feet long at each end.



Find T_c — Table III. $22^\circ 14'$ $T_1 = 1125.8)4^\circ$

$$\begin{array}{r}281.45\end{array}$$

Table IV. $\underline{.05}$ corr.

Table VI. $p = 0.94$; $q = 89.97$ — $281.50 = T_c$

nat tan $\frac{1}{2}(22^\circ 14') = 0.19649$ — $89.97 = q$

$0.19649 \times 0.94 = 0.18$ — $\underline{.18} = p \tan \frac{1}{2} I$

$371.65 = T_s$

$$\begin{array}{rl}
s_c = & 3^\circ 36' \\
2\,s_c = & 7^\circ 12' \\
I = & \underline{22^\circ 14'} \\
I - 2\,s_c = & 15^\circ 02' \\
L = & 4^\circ\overline{)15.0333} \\
 & 375.8
\end{array}
\qquad
\begin{array}{rl}
V = & 46 + 72.7 \\
 & \underline{3 + 71.7} = T_s \\
T.S. & 43 + 01.0 \\
 & \underline{1 + 80.0} = l_c \\
S.C. & 44 + 81.0 \\
 & \underline{3 + 75.8} = L \\
C.S. & 48 + 56.8 \\
 & \underline{1 + 80.0} = l_c \\
S.T. & 50 + 36.8
\end{array}$$

Table VI. $s_c = 3^\circ 36' = 3^\circ.6$
Deflection angles for spiral from
Table VII. for $s_c = 3^\circ.6$

Transit at	43 + 01.0 *T.S.*
$i = 0^\circ 01'$ to	43 + 19.0
0° 03′	43 + 37.0
0° 06′	43 + 55.0
0° 11′	43 + 73.0
0° 18′	43 + 91.0
0° 26′	44 + 09.0
0° 35′	44 + 27.0
0° 46′	44 + 45.0
0° 58′	44 + 63.0
1° 12′	44 + 81.0

Defl. angles for circular curve with transit at 44 + 81.0

$$\begin{array}{r}
s_c = 3^\circ 36' \\
i_c = \underline{1^\circ 12'}
\end{array}$$

back deflection to *T.S.* $= 2^\circ 24'$

for $c_i = 19$, $\frac{d_i}{2} = 0^\circ 23'$ 45

$2^\circ 23'$ 46

$4^\circ 23'$ 47

$6^\circ 23'$ 48

for $c_f = 56.8$, $\frac{d_f}{2} = \frac{1^\circ 08'}{7^\circ 31'}$ 48+56.8

$\frac{I - 2\,s_c}{2} = \frac{15^\circ 02'}{2} = 7^\circ 31'$ *Check*

192. Problem. *Given D_c and l_c.*

Required p, q, and other data for spiral

$$\text{from (145 } A\text{)} \quad s_c = \frac{l_c D_c}{200}. \qquad (145\ A)$$

The Am. Ry. Eng. Ass'n uses the following empirical formulas for values of p and q,

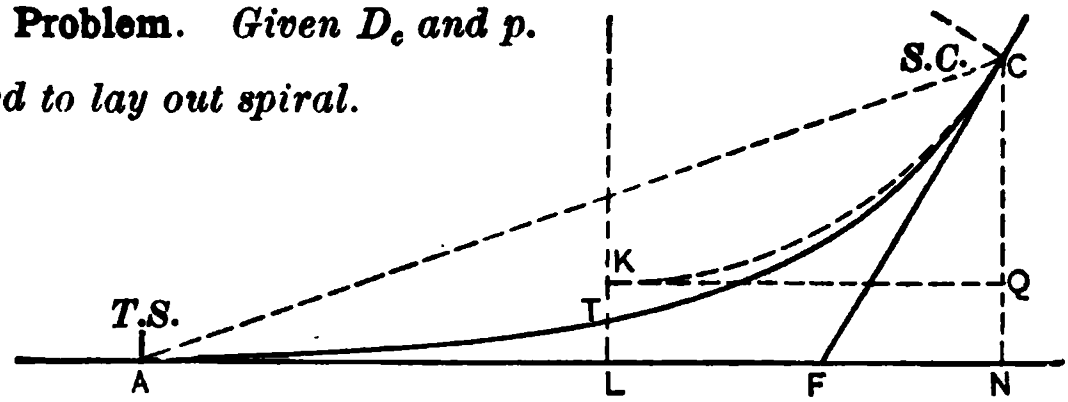
$$p = al_c - bD_c \qquad q = el_c - fD_c.$$

Tables of the coefficients a, b, e, f, condensed from the A. R. E. A. Tables are given in Table VII B for values of s_c differing by 30′; intermediate values may be interpolated.

The deflection angles may be found as before from Table VII.

193. Problem. *Given D_c and p.*

Required to lay out spiral.



from (145) $\quad \mathsf{KC} = \dfrac{l_c}{2}$ (approx.),

from (145 B) $\quad q = \dfrac{l_c}{2}$ (approx.)

$$\mathsf{CN} = x_c = \frac{l_c^3}{6\,R_c l_c} = \frac{l_c^2}{6\,R_c} \qquad \text{for spiral}$$

from (26) $\quad \mathsf{CQ} = \dfrac{c^2}{2\,R} = \dfrac{\left(\dfrac{l_c}{2}\right)^2}{2\,R_c} = \dfrac{l_c^2}{8\,R_c}$ (approx.) for circle

therefore $\quad \mathsf{CN} = \dfrac{4}{3}\mathsf{CQ} = \mathsf{CQ} + \dfrac{\mathsf{CQ}}{3} = \mathsf{CQ} + \mathsf{QN}$ (approx.)

$$\mathsf{CQ} = 3\,\mathsf{QN} = 3\,\mathsf{KL} = 3\,p \text{ (approx.)}$$

$$\mathsf{CN} = 4\,\mathsf{QN} = 4\,\mathsf{KL} \qquad \text{(approx.)}$$

from (144) $\quad \dfrac{x}{x_c} = \dfrac{l^3}{l_c^3} \qquad (149\ C)$

$$\mathsf{CN} = 2^3\mathsf{TL} = 8\,\mathsf{TL} = 4\,\mathsf{KL}$$

$$\mathsf{TL} = \frac{\mathsf{KL}}{2} = \frac{p}{2} \text{ (approx.)} \qquad (149\ D)$$

From CQ $= 3p$ the length of curve may be readily determined. If the center of the circular curve KC be at O, then

$$\text{KOC} = \text{CFN} = s_c$$

$$\text{vers KOC} = \frac{\text{CQ}}{\text{OK}} \quad \text{or} \quad \text{vers } s_c = \frac{3p}{R_c}$$

$$\frac{100\, s_c}{D_c} = L \text{ for circular curve KC}; \; l_c = 2L$$

from (146) $i_c = \frac{s_c}{3}$; for other deflections $i = i_c\left(\frac{l}{l_c}\right)^2$ (146 *A*)

The back deflection ACF $= 2\, i_c$.

By the above method, the values of s_c and l_c may be reached with substantial accuracy without the use of the spiral tables. Where close results are necessary, p may be re-computed by Table VII *B* from the values of s_c and l_c already found by the above formulas. If the new value of p is not sufficiently close to the given value, correct values of s_c and l_c may be found by trial. The value of q is found by Table VII *B*.

The deflection angles may then be taken from Table VII.

It will be understood that the method of § 193 is more laborious than the more common method of § 191; its value lies in the fact that it is thoroughly elastic and any given length of spiral may be used. In a similar way, if the value of p (together with D_c) determines the spiral to be used, the method of § 193 becomes useful.

Approximate Method.

Problem. *Given D_c and either l_c or p.*
Required s_c and the deflection angles without the use of tables.

Assume the long chord KC to be equal to $\frac{l_c}{2}$.

$$R_1 = 5730 \qquad R_a = \frac{5730}{D_a}$$

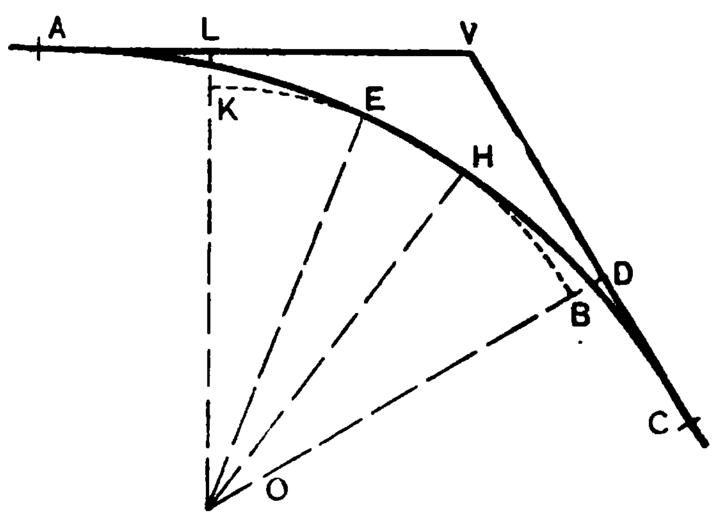
By § 193 find $3p$ from R_c and L by (26) or find L from R_c and $3p$ by (26)

$$L = q \text{ (approx.)}; \; s_c = \frac{l_c D_c}{200}; \text{ and } i = \frac{s_c}{3}$$

Other deflections are found by $i = i_c\left(\frac{l}{l_c}\right)^2$ (146 *A*)

194. Fieldwork of Laying out Spiral.

(*a*) Select on the ground the vertex V and measure I; or else fix on ground, point L opposite the point K where the circular curve will become parallel to tangent.



(*b*) Select the length l_c of spiral to join given circular curve; this may be taken from Table VI or computed by § 193 from D_c and p.

(*c*) Find value of q and s_c from Table VI or by § 193.

(*d*) Set *T.S.* at A by measuring T_s from vertex, or by measuring q from point L, as the case may be.

(*e*) With transit at *T.S.* run in spiral using deflection angles from Table VII.

(*f*) With transit at *S.C.* turn vernier to 0° and beyond 0° to measure angle $s_c - i_c$ (this will be $2\,i_c$ when s_c is less than 15°).

(*g*) Take backsight on *T.S.*, and when vernier reads 0° the line of sight is on auxiliary tangent.

(*h*) Run in circular curve by deflection angles; the central angle of circular curve $= I - 2\,s_c$.

(*i*) With transit at *S.T.* (*not* at *C.S.*) run in second spiral.

(*k*) "Check" on *C.S.*

(*l*) If the "check" is not substantially perfect, ***re-set the point at C.S.***

It is important that each spiral shall be correct throughout its entire length. In case the spiral and circular curve do not check properly at the *C.S.*, the discrepancy should be thrown into the circular curve where its effect will be unimportant.

When the circular curve is visible from the *C.S.* the general method of § 62 will give the best results, as follows:

(*A*) Lay out first spiral from *T.S.* to *S.C.*

(*B*) Lay out second spiral from *S.T.* to *C.S.*

(*C*) Set up transit at *C.S.* and lay out circular curve from *S.C.* to *C.S.* and check angle to *S.T.*

195. *Given D_c and l_c.*
Required to lay out spiral by offsets from the tangent.

From Table VI find value of x_c.
Find other values of x at convenient intervals by formula

$$x = x_c\left(\frac{l}{l_c}\right)^3 \qquad \text{(from 144)}$$

This method will be useful at times but more often spirals will be laid out by deflection distances.

Example. *Given $D_c = 4°$, $l_c = 240$.*
Required offsets from tangent to spiral.

Take offsets at middle, quarter, and eighth points.
Table VI gives:

for	$l_c = 240$	$x_c = 6.70$
at	$l_4 = 120$	$x_4 = 6.70 \div 8 = 0.8375$
	$l_2 = 60$	$x_2 = 0.8375 \div 8 = 0.1047$
	$l_1 = 30$	$x_1 = 0.1047 \div 8 = 0.0131$
	$l_3 = 90$	$x_3 = 0.0131 \times 3^3 = 0.35$
	$l_5 = 150$	$x_5 = 0.0131 \times 5^3 = 1.64$
	$l_6 = 180$	$x_6 = 0.0131 \times 6^3 = 2.83$
	$l_7 = 210$	$x_7 = 0.0131 \times 7^3 = 4.49$

The "cubic spiral" will be laid out by measuring successive chords of 30 ft. each, and measuring the proper offset from the tangent.

For the "Cubic Parabola,"

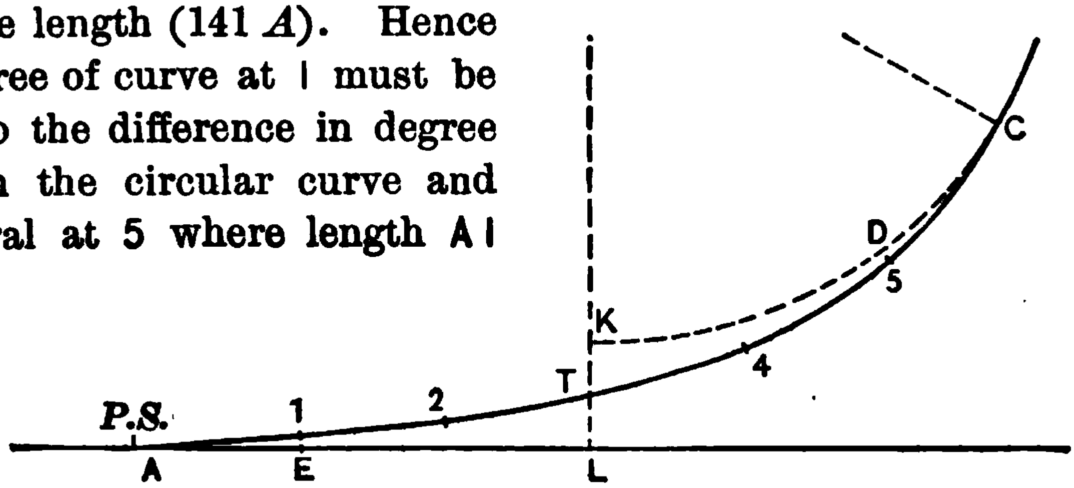
the formula is $$x = \frac{y^3}{6\,C}$$

whence $$x = x_c\left(\frac{y}{y_c}\right)^3$$

The computations may be the same as for the cubic spiral. The successive distances of 30 will be laid off on the tangent and the offset laid off at right angles to the tangent.

196. It may occasionally (although not frequently) happen that the entire spiral cannot be laid out from the *T.S.*, and it will be necessary to determine deflection angles when the transit is at some intermediate point on the spiral. It will be desirable to occupy some regular chord point.

In any Cubic Spiral, the degree of curve *D* increases uniformly with the length (141 *A*). Hence the degree of curve at I must be equal to the difference in degree between the circular curve and the spiral at 5 where length A I = C 5.



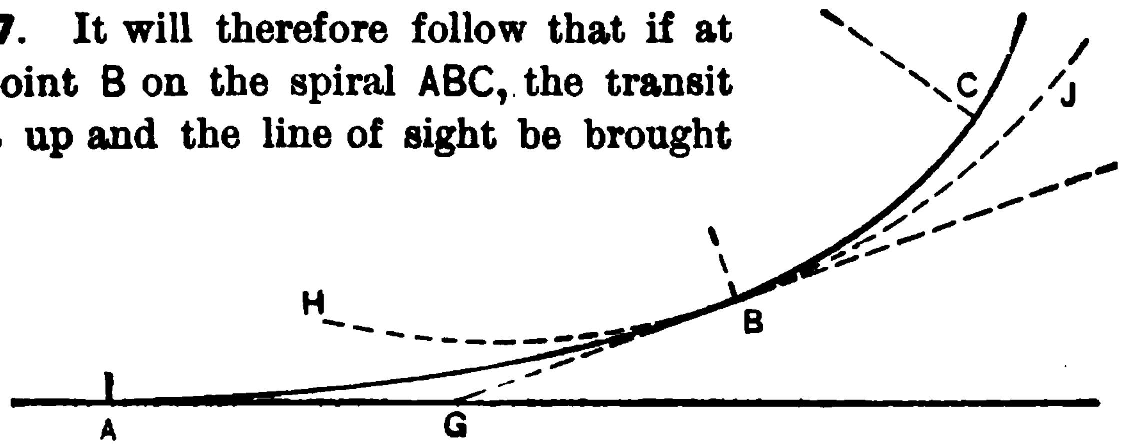
Since the divergence in the degree of the spiral is the same for a given distance, whether this divergence be from the tangent AL or from the curve CK, it will naturally follow from the principles established in § 69, that the offset to the spiral for a given distance from C will be the same as the offset for the same distance from A, since the change in degree at corresponding points is always the same whether from tangent or curve.

The same conclusion will be reached by referring to § 160 near the bottom of p. 93, where the elastic model and the "bending process" is referred to; this bending process being there found to be correct (approx.) from the demonstration § 158, p. 92. If this principle be correct, it will follow that KT = TL, which may be considered an extreme case. That KT = TL is demonstrated (in 149 *D*) to be correct is an additional assurance of the correctness of the principle stated above.

It will further follow if E I and D 5 are equal, and at equal distances from A and C respectively, that the angles E A I and D C 5 will be equal (closely). For the offset divided by the distance gives approximately the sine of the angle, and since the sines are equal, the angles also are equal; similarly the angles LAT and KCT are equal.

In other words, the divergence of any given spiral for a given distance, is the same either in offset or in angle, whether the divergence be from the tangent or from the circular curve.

197. It will therefore follow that if at any point B on the spiral ABC, the transit be set up and the line of sight be brought



on the auxiliary tangent BG at that point, then the deflection angle to any forward point on the spiral will be the sum of (1) the "total deflection angle," for the distance from B to that point, due to the circular curve HBJ, whose degree is the degree of the spiral at B; and (2) the "total deflection angle" from the original tangent for that spiral for the same distance reckoned from the *T.S.* For any back point, the deflection angle from this auxiliary tangent will be the difference between these angles.

The proper use of these deflection angles will allow the line of sight to be brought on the auxiliary tangent, as well as give means for setting all points on the spiral.

Example. Required forward deflection angles from point 6 on a spiral 300 feet long, to join 5° curve.

$$s_c = 7^\circ 30' = 7^\circ.5$$

The tangent BG is found by laying off from chord AB, twice the forward deflection to point 6, or $2 \times 54' = 1^\circ 48'$.

D at point 6 $= 0.6 \times 5^\circ$			$= 3^\circ 00'$
Deflection angle for 30 ft. on 3° curve			$= 27'$
The total angles will be at point	7,	$27' + 01'$	$= 28'$
	8,	$54' + 06'$	$= 1^\circ 00'$
	9,	$81' + 13'$	$= 1^\circ 34'$
	10,	$108' + 24'$	$= 2^\circ 12'$
The back deflections will be at point	5,	$27' - 01'$	$= 26'$
	4,	$54' - 06'$	$= 48'$
	3,	$81' - 13'$	$= 1^\circ 08'$
	2,	$108' - 24'$	$= 1^\circ 24'$
	1,	$135' - 37'$	$= 1^\circ 38'$
	0,	$162' - 54'$	$= 1^\circ 48'$

The back deflection from point 6 to *T.S.* also $= 0^\circ 54' \times 2 = 1^\circ 48'$.

198. The method of determining the angle between the tangent and any chord of the spiral may now be readily understood, and is described in the Proceedings of the Am. Ry. Eng. Ass'n as follows:

"Dividing the spiral into ten equal parts, the angle between the tangent at the *T.S.* and the chord from a spiral $(n-1)$ to the point (n) is the central angle of the spiral from the *T.S.* to the point $(n-1)$, plus the degree of curve at the point $(n-1)$ times half the distance in stations from $(n-1)$ to (n), plus the deflection from the tangent at the *T.S.* to the chord subtending the first tenth of the spiral"

or $$\alpha_n = \left(\frac{n-1}{10}\right)^2 s_c + \frac{n-1}{100} s_c + \frac{s_c}{300}$$

$$= \frac{3n^2 - 3n + 1}{300} s_c$$

"Substituting the successive numerals 1 to 10 for n, the successive values" of α "are 1, 7, 19, 37, 61, 91, 127, 169, 217, and 271 — 300ths" of s_c.

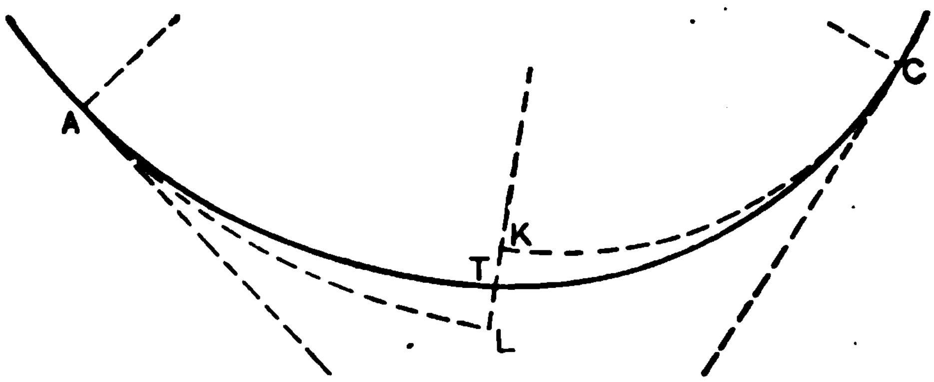
In a similar fashion the Am. Ry. Eng. Ass'n has calculated the forward and backward deflections when the transit is at an intermediate station on the spiral and Table VII *A* shows these as multiples (by full numbers) of the first chord deflection angle i_1.

In finding the numbers for this Table the assumption was made that the deflection angle from the *T.S.* to any point is one third the spiral angle to that point, which is approximate only where s_c exceeds 15°. When the transit is set at a point P' and a deflection angle (from the auxiliary tangent at P') is taken to another point P'' the Am. Ry. Eng. Ass'n states:

"The formulas and rule are approximate and should not be used when the central angle from P' to P'' exceeds the central angle from the *T.S.* by more than 15°."

Table VII *A* furnishes a very simple method of finding forward and back deflections when it becomes necessary to set the transit at an intermediate point on the spiral. While multiplying i_1 may be somewhat burdensome, setting up at intermediate points will not be frequent, and simplicity is of prime importance.

199. Compound Curves. In the case of Compound Curves, it is proper and desirable that easement curves should be introduced between the two circular curves forming the compound curve.



Problem. *Given in a Compound Curve, D_l, D_s, p, or l.*
Required the Deflection Angles for a Cubic Spiral to connect the circular curves.

(*a*) Find by Table VII or by § **193** the Deflection Angles proper for a Cubic Spiral to connect a tangent with a circular curve of degree $= D_l - D_s$.

Let these $= i_1, i_2, i_3$, etc.

(*b*) Find the deflection angles to corresponding points on one of the circular curves, the auxiliary tangent for these being at the point where the Cubic Spiral leaves this circular curve (where the transit will be set).

Let these $= \frac{d_1}{2}, \frac{d_2}{2}, \frac{d_3}{2}$, etc.

(*c*) The required total deflections from A will be for

point 1 $\frac{d_1}{2} + i_1$ point 2 $\frac{d_2}{2} + i_2$

point 3 $\frac{d_3}{2} + i_3$ etc.

The required total deflections from C will be for

point 1 $\frac{d'_1}{2} - i_1$ point 2 $\frac{d'_2}{2} - i_2$ etc.

Similar procedure may be followed if it be desired to lay out the spiral by offsets. Convenient points may be set on the circular curves and the offsets taken from either curve.

Example. *Given* $D_l = 4°$, $D_s = 7°$, $l_c = 200$.

From Tables VI and VII find deflection angles for a curve of $D = 7° - 4° = 3°$ with $l_c = 200$, where $s_c = 3° 00'$. On 4° circular curve deflection angle for 20′ chord = 0° 24′.

		4° curve deflection	+	spiral deflection		
for point	1	0° 24′	+	0° 01′	=	0° 25′
	2	0° 48′	+	02′	=	0° 50′
	3	1° 12′	+	05′	=	1° 17′
	4	1° 36′	+	10′	=	1° 46′
	5	2° 00′	+	15′	=	2° 15′
	6	2° 24′	+	22′	=	2° 46′
	7	2° 48′	+	29′	=	3° 17′
	8	3° 12′	+	38′	=	3° 50′
	9	3° 36	+	49′	=	4° 25′
	10	4° 00′	+	60′	=	5° 00′

These are total deflection angles from auxiliary tangent when the transit is on the 4° curve.

Field work.

(*a*) Fix L or K in ground from topography or other practical requirements, the same as for any compound curve.

(*b*) Assume l_c and compute p.

(*c*) Fix A and C, true transit points on curve at distances $\frac{l_c}{2}$ from L or K.

(*d*) Set transit at A.

(*e*) Bring line of sight on auxiliary tangent at A.

(*f*) Set off "total deflection" angles to spiral and run in spiral.

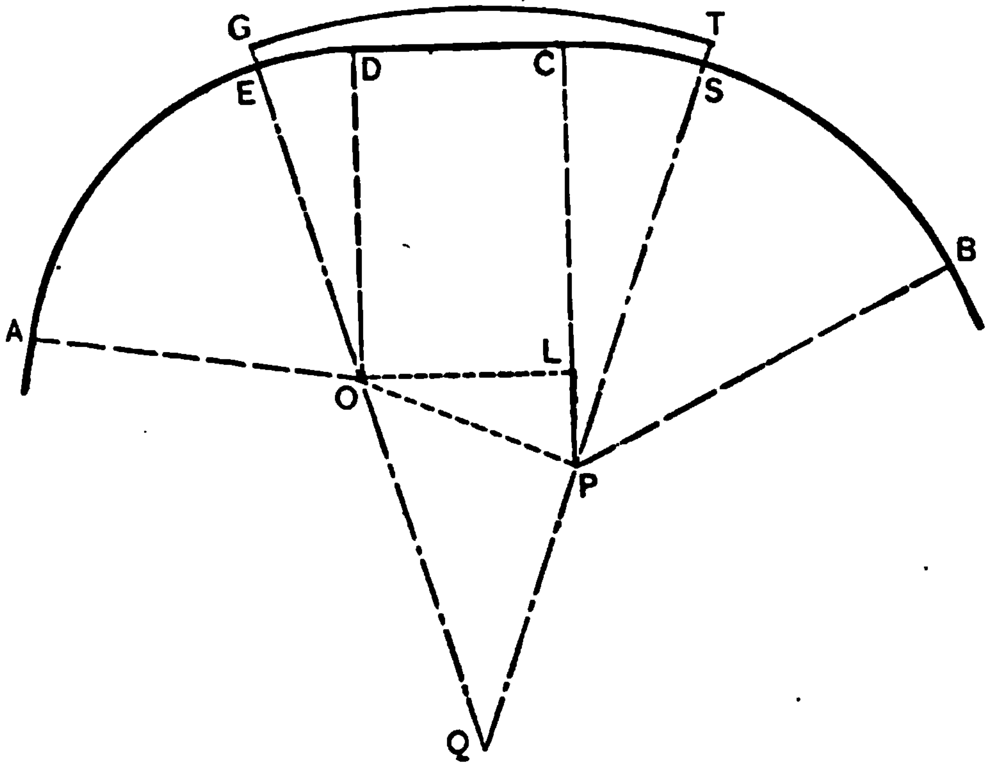
200. Determination of Length of Spiral.

The basis used by the Am. Ry. Eng. Ass'n for fixing the proper length of spiral is the increase per second of the elevation of the outer rail. Too rapid an increase, it is thought, will cause some discomfort to passengers. The discussion is too extended for a pocket book, and will not be attempted here.

The Am. Ry. Eng. Ass'n has prepared a diagram shown as Table VII *C* which covers the recommendation of the Association for fixing the length of spirals.

201. Problem. *Given two simple curves with connecting tangent.*

Required to substitute a simple curve of given radius with connecting spirals at each end.



Let DC $= t =$ given tangent, connecting the two curves AD and CB of radii R_s and R_l respectively.

Let GT be the given new curve of radius R_c.

Assume suitable spirals and find from table VI, GE $= p_1$ and ST $= p_2$ for these spirals, also q_1 and q_2.

Join OP and draw perpendicular OL.

Then $\tan \text{LOP} = \dfrac{R_l - R_s}{t}$; $\text{OP} = \dfrac{t}{\cos \text{LOP}}$

In the triangle OPQ there are given

$$\text{OP} = \frac{t}{\cos \text{LOP}}; \ \text{OQ} = R_c - R_s - p_1\,; \ \text{QP} = R_c - R_l - p_2$$

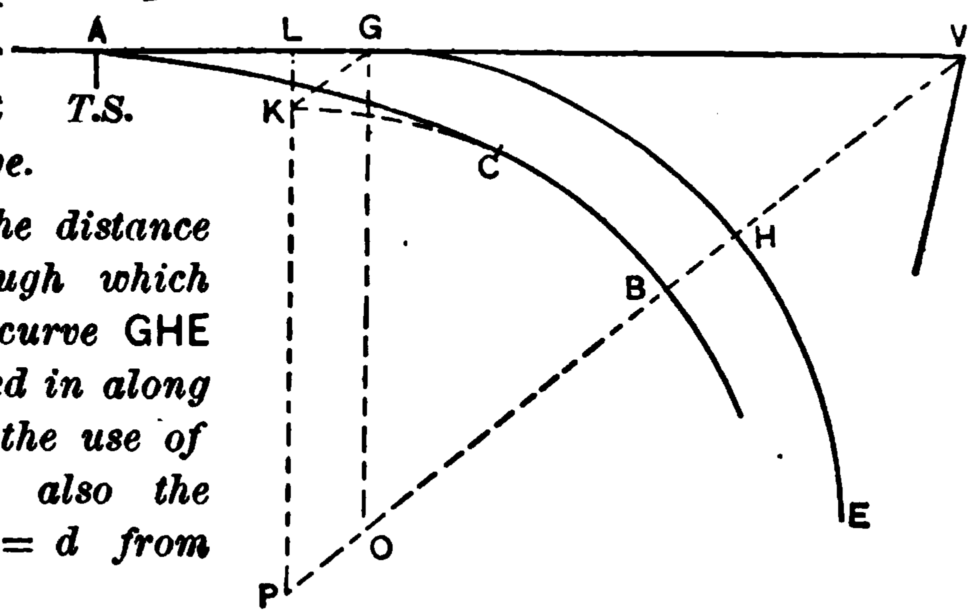
Solve this triangle for OQP, QOP, OPQ.

Then CPS $= 180° - (\text{OPQ} + \text{OPL})$

EOD $= 90° - (\text{QOP} + \text{LOP})$

Knowing the stations of D and C, the stations of E and S are readily found and also the stations of the *C.S.* and *S.C.* by applying q_1 and q_2.

202. Problem. *Given I and R_c for circular curve* GHE, *also p and corresponding q for a spiral to fit the given curve.*



Required the distance BH $= h$ *through which the circular curve* GHE *must be moved in along* VO *to allow the use of this spiral; also the distance* GA $= d$ *from P.C. to T.S.*

$$BH = PO = KG = \frac{KL}{\cos LKG}$$

$$h = \frac{p}{\cos \frac{1}{2} I} \tag{150}$$

$$GA = AL + LG$$

$$= AL + LK \tan LKG$$

$$d = q + p \tan \tfrac{1}{2} I \tag{150 A}$$

Problem. *Given I, R_c and h.*
Required p and d.

$p = h \cos \frac{1}{2} I$

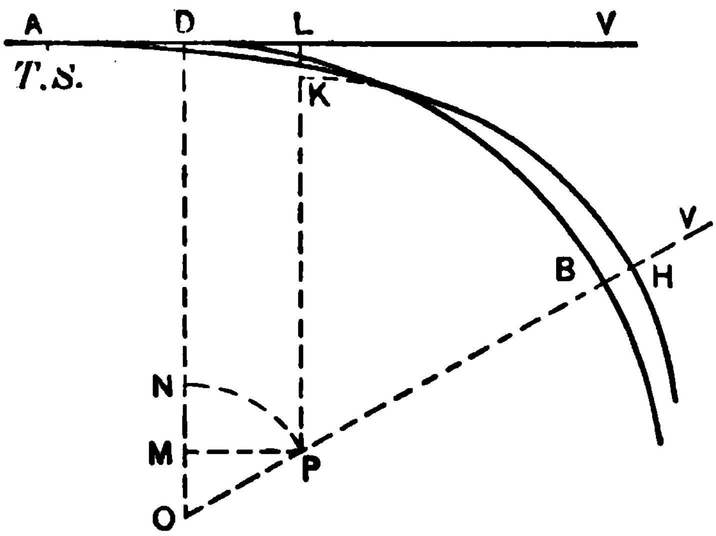
q is found by Table VII B or by § **193**.

$d = q + p \tan \frac{1}{2} I.$

In re-running old lines to introduce spirals, where an original circular curve is to be replaced by a spiral and a circular curve of the same degree, it is clear that the circular curve must necessarily be set in towards the center from H by a certain amount h. Practical considerations may often fix the distance h by which the curve must be moved. The method of § **193** will be found of considerable value in revisions of line since it allows great flexibility in the selection of spirals.

203. It may sometimes seem more desirable to change the radius of the circular curve so as to keep the new alignment in such position as to show as little deviation as possible from the old alignment and at the same time keep the length of line as nearly as possible unchanged. This may be accomplished as indicated in the figure below, where the line is carried outwards at B and inwards near D and L.

Problem. *Given I and R_1 for circular curve* DB; *also p of spiral; also* BH $=h$ *measured along* VO *locating* H *through which new circular curve is to pass to allow the use of this spiral.*



Required the radius $R_2 =$ KP *of the new curve* KH; *also q consistent with p and R_2; also distance* DA $= d$ *from P.C. to T.S.*

$$\begin{aligned}
\mathrm{PO} = \mathrm{NO} &= \mathrm{OB} + \mathrm{BH} - \mathrm{PH} \\
&= R_1 + h - R_2 \\
\mathrm{OM} &= \mathrm{DO} - \mathrm{DM} \\
&= \mathrm{DO} - \mathrm{PK} - \mathrm{KL} \\
&= R_1 - R_2 - p \\
\mathrm{NM} &= \mathrm{NO} - \mathrm{OM} = h + p \\
\mathrm{PO} \operatorname{vers} \mathrm{NOP} &= \mathrm{NM} \\
(R_1 - R_2 + h) \operatorname{vers} \tfrac{1}{2} I &= h + p
\end{aligned}$$

$$R_1 - R_2 + h = \frac{h + p}{\operatorname{vers} \frac{1}{2} I} \qquad (151)$$

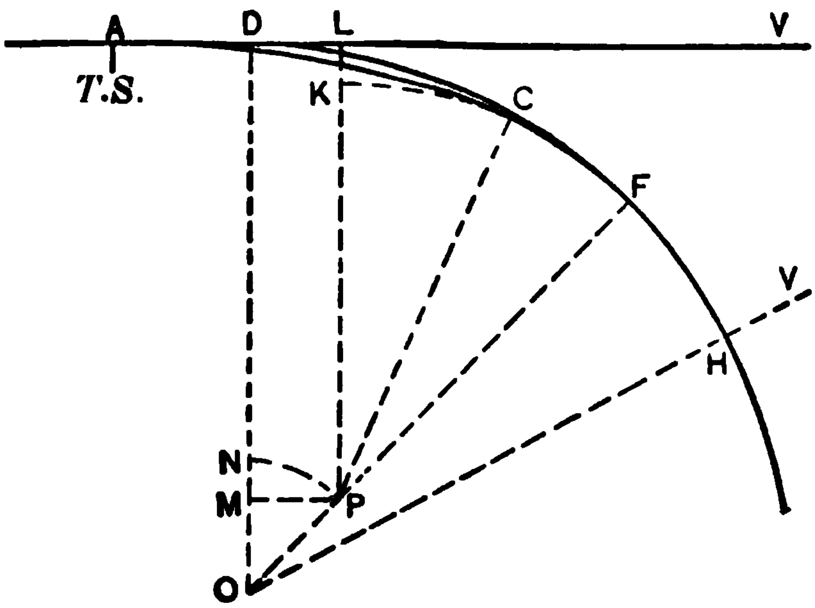
Find q from p and R_2, by § **193**.

Then

$$\begin{aligned}
\mathrm{DA} &= \mathrm{AL} - \mathrm{DL} \\
&= \mathrm{AL} - \mathrm{MP} \\
d &= q - (R_1 - R_2 + h) \sin \tfrac{1}{2} I. \qquad (151\,A)
\end{aligned}$$

204. When it is necessary to keep the middle point H unchanged, on account of a bridge, or heavy embankment, or otherwise, it then becomes necessary to make part of the curve sharper, as CF in the figure below. The most practical method appears to be to assume the angle FOH, the part of the curve to remain unchanged; also assume the value of p and compute all other necessary data.

Problem. *Given I and R_1 of circular curve, also p of proposed spiral, also angle FOH $= I_1$ of the circular curve which is to remain unchanged.*



Required the radius R_2 of new curve CF, to compound with original curve FH; also q consistent with p and R_2; also the distance DA $= d$ from P.C. to T.S.

$$\text{FOH} = I_1$$
$$\text{DOH} = \tfrac{1}{2} I$$
$$\text{OP vers NOP} = \text{NM} = \text{MD} - \text{ND}$$
$$= \text{LP} - \text{KP} = p$$
$$(R_1 - R_2) \text{ vers } (\tfrac{1}{2} I - I_1) = p$$
$$R_1 - R_2 = \frac{p}{\text{vers } (\frac{1}{2} I - I_1)} \tag{152}$$

Find q from p and R_2 by § **193**.

Then

$$\text{DA} = \text{AL} - \text{DL}$$
$$= \text{AL} - \text{MP}$$
$$d = q - (R_1 - R_2) \sin (\tfrac{1}{2} I - I_1) \tag{152 A}$$

By making FOH $= I_1 = 0$, R_2 becomes continuous from the first spiral, through H and to its connection with the second spiral.

Another practical method would be to assume R_2 and p and compute I_1, q, d.

CHAPTER XI.

SETTING STAKES FOR EARTHWORK.

205. The first step in connection with Earthwork is staking out, or "**Setting Slope Stakes,**" as it is commonly called.

There are two important parts of the work of setting slope stakes:

I. Setting the stakes.

II. Keeping the notes.

The data for setting the stakes are:

(*a*) The ground with center stakes set at every station (sometimes oftener).

(*b*) A record of bench marks, and of elevations and rates of grades established.

(*c*) The base and side slopes of the cross-section for each class of material.

In practice, notes of alignment, a full profile, and various convenient data are commonly given in addition to the above.

206. **I. Setting the Stakes.** The work consists of:

(*a*) Marking upon the back of the center stakes the "cut" or "fill" in feet and tenths, as

C 2.3 or F 4.7.

(*b*) Setting side stakes or slope stakes at each side of the center line at the point where the side slope intersects the surface of the ground, and marking upon the inner side of the stake the "cut" or "fill" at that point.

207. (*a*) The process of finding the cut or fill at the center stake is as follows:

Given for any station the height of instrument $= h_i$, *and the elevation of grade* $= h_g$.

Then the required *rod reading for grade*

$$r_g = h_i - h_g. \tag{153}$$

It is not necessary to figure h_g for each station.

Let $h_{g_0} = h_g$ at Sta. 0

$h_{g_1} = h_g$ " " 1

$h_{g_2} = h_g$ " " 2, etc.

Also use similar notation for r_g.

Let $g =$ rate of grade (rise per station)

Then
$$h_{g_1} = h_{g_0} + g$$
$$h_{g_2} = h_{g_1} + g$$
$$h_{g_3} = h_{g_2} + g, \text{ etc.}$$

$$r_{g_0} = h_i - h_{g_0}$$
$$r_{g_1} = h_i - h_{g_1}$$
$$= h_i - (h_{g_0} + g) = h_i - h_{g_0} - g$$
$$r_{g_1} = r_{g_0} - g \tag{154}$$

Similarly, $r_{g_2} = r_{g_1} - g$, etc.

It will be necessary, or certainly desirable, to figure h_g and r_g anew for each new h_i. It is well to figure h_g and r_g (as a check) for the last station before each turning point.

Example. $h_i = 106.25$

Sta. 0,	grade elevation	100.00	
			rate + 1.00
5,	" "	105.00	
			" + 0.50
10,	" "	107.50	

$$r_{g_0} = 106.25 - 100.00 = 6.25 \qquad 6.25$$

$$r_{g_1} = \qquad 6.25 - \overset{g}{1.00} = 5.25$$

$$r_{g_2} = \qquad 5.25 - 1.00 = 4.25$$

$$r_{g_3} = \qquad 4.25 - 1.00 = 3.25$$

$$r_{g_4} = \qquad 3.25 - 1.00 = 2.25$$

$$r_{g_5} = \qquad 2.25 - 1.00 = 1.25$$

Change in rate

$$r_{g_6} = \qquad 1.25 - 0.50 = 0.75$$

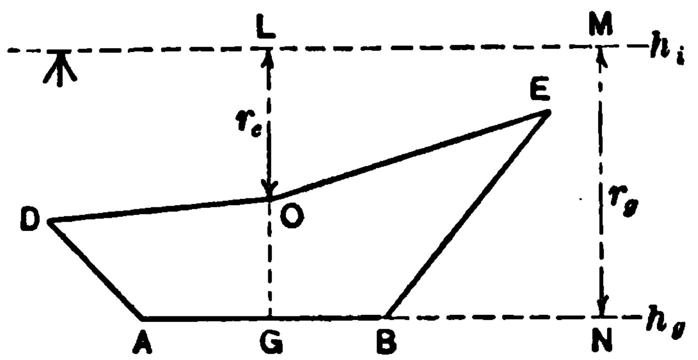
$$r_{g_7} = \qquad 0.75 - 0.50 = 0.25$$

It is found necessary to take a *T.P.* here, and we therefore find

$$h_{g_7} = h_{g_5} + 2g$$
$$= 105.00 + 1.00 = 106.00$$
$$r_{g_7} = h_i - h_{g_7} = 106.25 - 106.00 = 0.25$$

Therefore all intermediate values r_{g_1}, r_{g_2}, etc., are "checked."

208. Having thus found r_g, next, by holding the rod upon the surface of the ground at the center stake, the rod reading $r_c =$ LO is observed from the instrument. The cut or fill



$$c = \text{OG} = \text{MN} - \text{LO}$$
$$= r_g - r_c \quad (155)$$

In the figure given the values of r_g and c are positive; a positive value of c indicates a "cut," a negative value of c indicates a "fill."

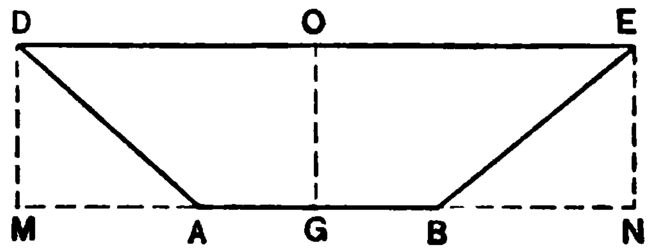
It can be shown that in the two cases of "fill,"

(1) When h_i is greater than h_g, and
(2) When h_i is less than h_g,

the formula given will hold good by paying due attention to the sign of r_g, whether + or −.

209. (*b*) **Setting the Stake for the Side Slope.**

(1) ***When the surface is level.***



Let $b = \mathsf{AB}$ = base of section

$c = \mathsf{OG}$ = center height

$s = \frac{\mathsf{BN}}{\mathsf{EN}} = \frac{\mathsf{AM}}{\mathsf{DM}}$ = side slope

$d = \mathsf{OD} = \mathsf{OE}$ = distance out

Then $d = \mathsf{GB} + \mathsf{BN}$

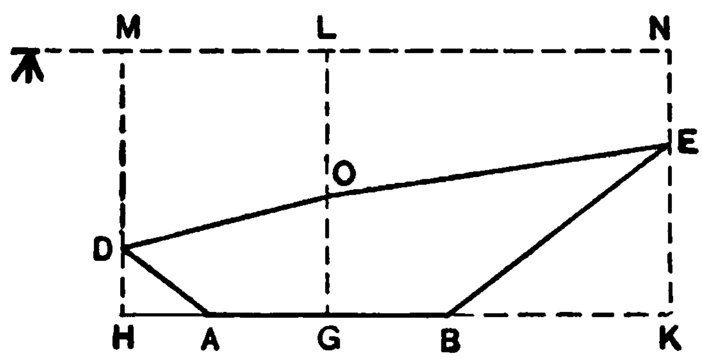
$= \frac{1}{2}b + s \times \mathsf{DM} = \frac{1}{2}b + s \times \mathsf{EN}$

$$= \frac{1}{2}b + sc \qquad (156)$$

Setting the Stake for the Side Slope.

(2) ***When the surface is not level.***

Here the process is less simple.



Let $b = \mathsf{AB}$ = base

$c = \mathsf{OG}$ = center height (or cut)

$s =$ slope

$h_r = \text{EK} =$ side height right

$h_l = \text{DH} =$ " " left

$d_r = \text{GK} =$ distance out right

$d_l = \text{GH} =$ " " left

Then
$$\left.\begin{aligned} d_r &= \tfrac{1}{2}b + sh_r \\ d_l &= \tfrac{1}{2}b + sh_l \end{aligned}\right\} \qquad (157)$$

But h_r and h_l are not known. It is evident from the figure that $h_r > c$ and $h_l < c$ in the case indicated, and therefore

$$d_r > \tfrac{1}{2}b + sc$$
$$d_l < \tfrac{1}{2}b + sc$$

It would be quite possible in many cases to take measurements such that the rate of slope of the lines OE and OD would be known, and the positions of E and D determined by calculation from such data. But speed and results finally correct are the essentials in this work, and these are best secured by finding h_l and h_r and the corresponding d_l and d_r upon the ground by a series of approximations, as described below.

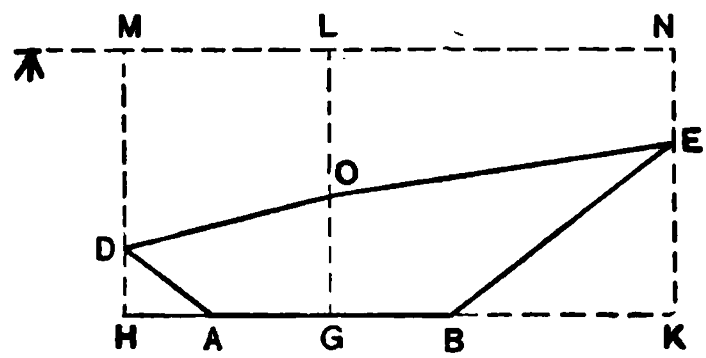
Having determined c, use this as a basis, and make an estimate at once as to the probable value of h_r at the point where the side slope will intersect the surface, and calculate $d_r = \frac{1}{2}b + sh_r$ to correspond.

Measure out this distance, set the rod at the point thus found, take the rod reading on the surface, and if the cut or fill thus found from the rod reading yields a value of d_r equal to that actually measured out, the point is correct. Otherwise make a new and close approximation from the better data just obtained, always starting with h_r and calculating d_r, and repeat the process until a point is reached where the cut or fill found from the rod reading yields a distance out equal to that taken on the ground. Then set the stake, and mark the cut or fill corresponding to h_r upon the inner side, as previously stated

Perform the same operation in a similar way to determine $d_l = \frac{1}{2}b + sh_l$, and mark this stake also upon the inner side with a cut or fill equal to h_l.

It requires a certain amount of work in the field to appreciate fully the process here outlined, but which in practice is very simple. It may impress some as being unscientific, and at first trial as slow, but with a little practice it is surprising how rapidly, almost by instinct, the proper point is reached, often within the required limits of precision at the first trial, while more than two trials will seldom be necessary, except in difficult country.

The instrumental work is just the same in principle as at the center stake.



Let $\quad r_r = \mathrm{NE} =$ rod reading at slope stake right,

then
$$\mathrm{KN} - \mathrm{NE} = r_g - r_r = h_r$$

here r_g is the same for center, right and left of section.

In some cases it may be necessary to make one or more resettings of the level in order to reach the side stakes from the center stake. In this case, of course, a new r_g must be calculated from the new h_t. This introduces no new principle, but makes the work slower.

A "slope-board" or "level-board" has quite frequently been used to advantage. In certain sections of country this might be considered almost indispensable. It consists simply of a long, straight-edge of wood (perhaps 15 ft. long) with a level mounted in the upper side. It is used with any self-reading rod. A rod quickly hand marked will serve the purpose well. Having given the cut or fill at the center, or at any point in the section, the leveling for the side stakes, and for any additional points, can readily, and with sufficient accuracy, be done by this "level-board," and the necessity for taking new turning points and resetting the level avoided.

210. II. *Keeping the Notes.*

The form of note-book used for keeping the notes of slope stakes and of center cuts and fills, often called "cross-section" notes, is shown on the following two pages.

The left-hand column for stations should read from bottom to top.

The surface elevations in column 2 are *not obtained directly from the levels*, but result from adding to the grade elevation at any station the cut or fill at that station, paying due attention to the signs. This column of surface elevations need not be entered up in the field, but may be filled in as office work more economically.

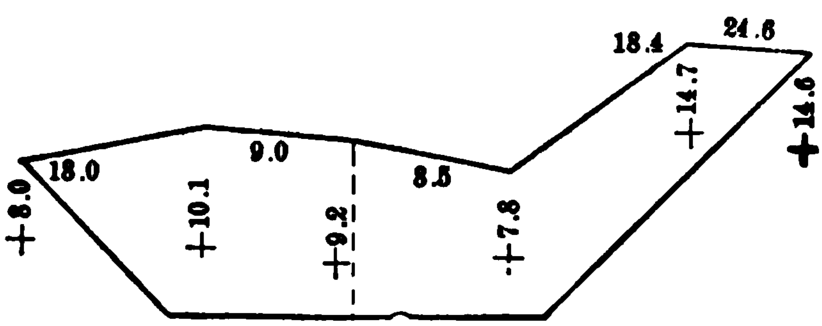
The column of grade elevations consists of the grade elevations as figured for each station.

The figures marked + are cuts in feet and tenths, and those marked − are fills; the figures above the cuts and fills are the distances out from the center, and the position in the notes, whether right or left of the center, corresponds to that on the ground.

The columns on the right-hand page are used for entering, when computed, the "quantities," or number of cubic yards, in each section of earthwork.

The column "**General Notes**" is used for entering extra measurements (of ditches, etc.) not included in the regular cross-section notes; also notes of material "hauled"; classification of material and various other matters naturally classed under the head of "Remarks."

When the surface is irregular between the center and side stakes, additional rod readings and distances out are taken, and the results entered as shown for station 0 on p. 144, the section itself being as shown below in the sketch.



Station 0

211. Form of Cross-Section Book (left-hand page).

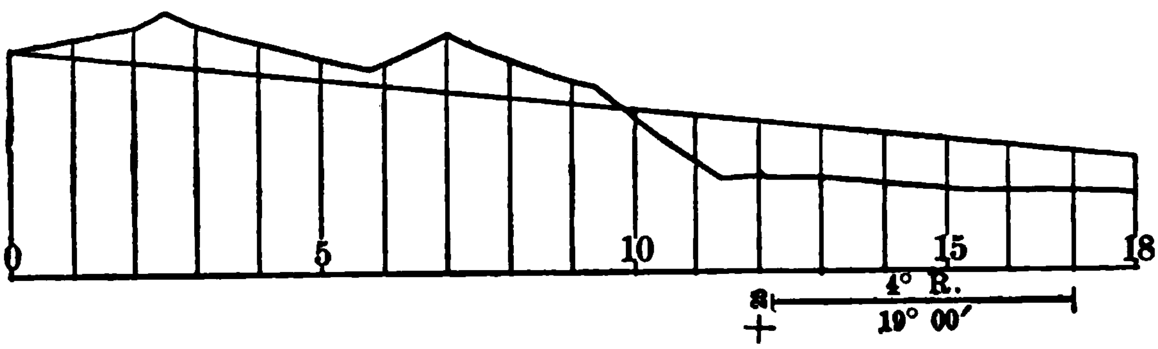
(Date)
(Names of Party)
Base 20 ; 1 to 1
14 ; $1\frac{1}{2}$ to 1

Station	Surface Elev.	Grade Elev.	Cross-Section
5	97.1	105.00	$\frac{18.4}{-7.6}$ $\quad -7.9 \quad$ $\frac{19.4}{-8.3}$
+69.7 *P.T.*	94.4	104.70	$\frac{22.1}{-10.1}$ $\quad -10.3 \quad$ $\frac{23.0}{-10.7}$
4	96.9	104.00	$\frac{19.3}{-8.2}$ $\quad -7.1 \quad$ $\frac{17.0}{-6.7}$
+27.2 *P.C.*	98.0	103.27	$\frac{16.6}{-6.4}$ $\quad -5.3 \quad$ $\frac{12.4}{-3.6}$
3	98.1	103.00	$\frac{16.0}{-6.0}$ $\quad -4.9 \quad$ $\frac{10.9}{-2.6}$
+87	100.6	102.87	$\frac{13.3}{-4.2}$ $\quad -2.3 \quad$ $\frac{7.0}{0.0}$
+76	102.8	102.76	$\frac{10.3}{-2.2}$ $\quad 0.0 \quad$ $\frac{11.9}{+1.9}$
+64	103.7	102.64	$\frac{10.0}{0.0}$ $\quad +1.1 \quad$ $\frac{13.2}{+3.2}$
+50	106.4	102.50	$\frac{18.4}{+8.4}$ $\quad +3.9 \quad$ $\frac{17.1}{+7.1}$
2	115.1	102.00	$\frac{16.7}{+6.7}$ $\quad +13.1 \quad$ $\frac{26.7}{+16.7}$
1	117.7	101.00	$\frac{22.7}{+12.7}$ $\frac{10.0}{+17.2}$ $\quad +16.7 \quad$ $\frac{10.0}{+18.1}$ $\frac{22.2}{+12.2}$
0	109.2	100.00	$\frac{18.0}{+8.0}$ $\frac{9.0}{+10.1}$ $\quad +9.2 \quad$ $\frac{8.5}{+7.8}$ $\frac{18.4}{+14.7}$ $\frac{24.6}{+14.6}$

212. **(Right-hand Page.)**

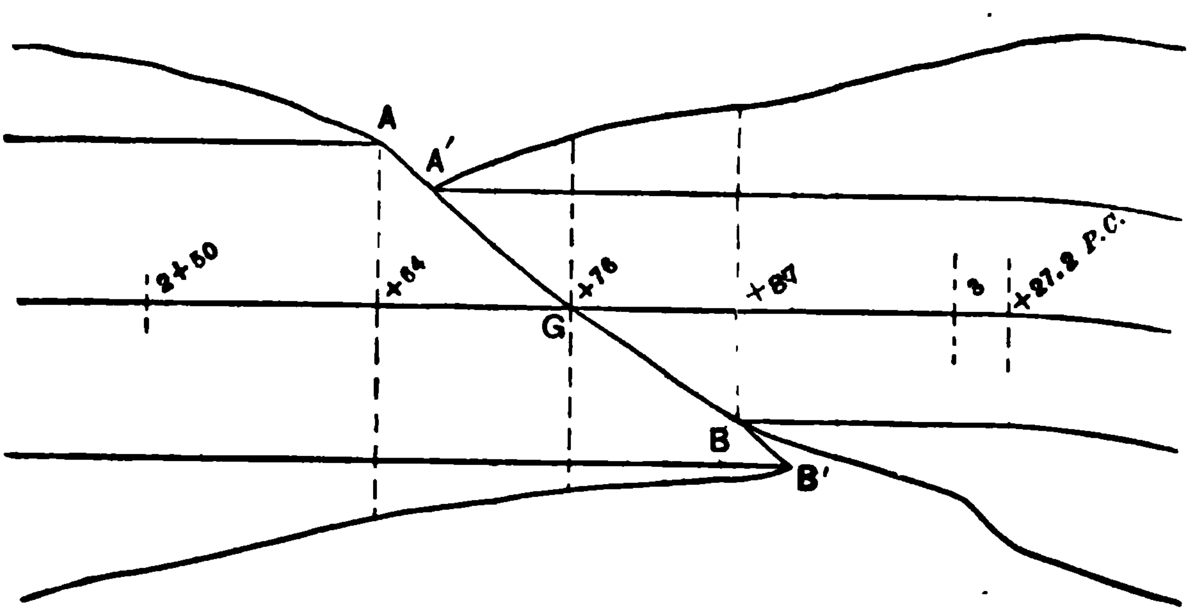
Excavation			Embankment	General Notes
L. Rock	S. Rock	Earth		

213. Cross-sections are taken at every full station, at every *P. C.* or *P. T.* of curve, wherever grade cuts the surface, and in addition, at every break in the surface. In the figure below, showing a profile, sections should be taken at the following stations: —



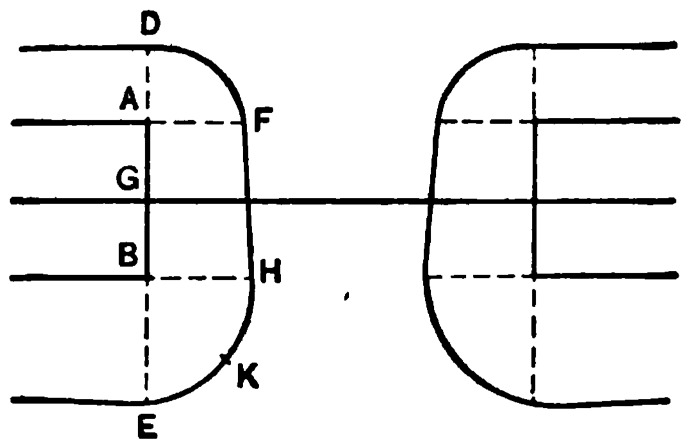
At Stations 0, 1, 2, 2 + 52, 3, 4, 5, 5 + 80, 6, 7, 8, 9, 9 + 29, 9 + 82, 10, 11, 11 + 30, 12, 12 + 25 *P.C.*, 13, 14, 15, 16, 17 *P.T.*, 18.

214. It is not necessary actually to drive stakes in *all* cases where a cross-section is taken and recorded, but in every case where they will aid materially in construction stakes should be set. It is best to err on the safe side, which is the liberal side. In passing from cut to fill, it is customary to take full cross-sections, not only at the point where the grade line cuts the surface at the *center* line of survey, but also where the grade cuts the surface at the outside of the base, both *right* and *left*, as in the figure below, which illustrates the notes on p. 144; full cross-sections are taken not only at stations 2 + 76, but also at 2 + 64 and 2 + 87.



215. Stakes are actually set at the center G and at the point A, where the outside line of the base of *Excavation* cuts the surface, and at B, where the outside line of the base of *Embankment* cuts the surface. It is not customary to set stakes or record the notes for the points A′ and B′. The stakes at A, G, and B are a sufficient guide for construction, and the solidities or "quantities" would in general be affected only slightly by the additional notes if they were made. When the line AGB crosses the center line nearly at right angles, it would not be necessary to take more than one section so far as the notes are concerned. It is well, however, to set the stakes A and B exactly in their proper position.

216. Wherever an opening is to be left in an Embankment for a bridge or for any other structure, stakes should be set as in the figure below: —



At A and B (at the side of the base and top of the slopes AF and BH) stakes should be set marked "*Bank to Grade*"; and at F and H (at the foot of the slopes) stakes should be set marked "*Toe of Slope.*" Where the bank is high, an additional stake K at foot of slope may be set as an aid to construction. The stakes at D and E should also be set as ordinary slope stakes.

217. The "level notes" proper, or the record of heights of instrument, bench marks, turning points, etc., used in setting slope stakes, are usually kept separate from the cross-section notes. One reason for this is that level notes run from top to bottom of page, while cross-section notes read from bottom to top of page. The level notes should be kept either in the back

of the cross-section book or in a level book carried for that purpose. Keeping these or any other notes on a slip of paper is bad practice.

218. Earthwork can be most readily computed when the section is a "*Level Section,*" that is when the surface is level across the section; but this is seldom the case, and for purposes of final computation it is not often attempted to take measurements upon that basis.

219. In general, in railroad work, the ground is sufficiently regular to allow of "*Three-Level Sections*" being taken, one level (elevation) at the center and one at each slope stake, as shown by these notes, where Base is 20, and Slope $\frac{1}{2}$ to 1:—

$$\frac{11.3}{+2.6} \qquad +4.2 \qquad \frac{12.8}{+5.5}$$

The term "*Three-Level Section*" is usually applied only to *regular* sections where the widths of base on each side of the center are the same. In regular three-level sections the calculation of quantities can be made quite simple. To facilitate the final estimation of quantities, it is best to use three-level sections as far as possible.

220. In many cases where three-level sections are not sufficient, it may be possible to use "*Five-Level Sections,*" consisting of a level at the center, one at each side where the *base* meets the side slope, and one at each side slope stake, as shown by the following notes:—

Base 20, Slope 1 to 1,

$$\frac{22.7}{+12.7} \qquad \frac{10.0}{+17.2} \qquad +16.7 \qquad \frac{10.0}{+13.1} \qquad \frac{22.2}{+12.2}$$

The term "*Five-Level Section*" is usually applied only to regular sections where the base and the side slopes are the same on each side of the center.

221. Where the ground is very rough, levels have to be taken wherever the ground requires, and the calculations must be made to suit the requirements of each special case, although certain systematic methods are generally applicable. Such sections are called "*Irregular Sections.*"

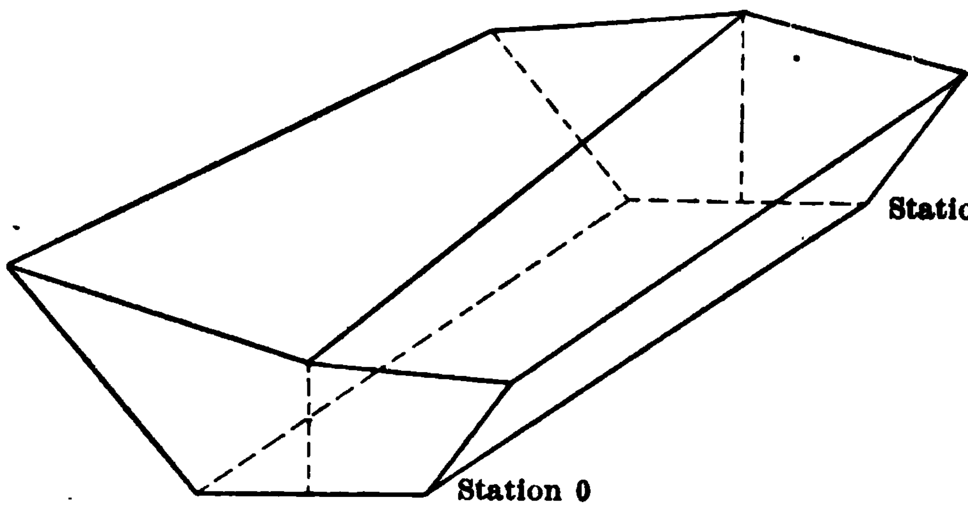
CHAPTER XII.

METHODS OF COMPUTING EARTHWORK.

222. In calculating the volumes or "quantities" of Earthwork, the principal methods used are as follows: —

I. Averaging End Areas. II. Prismoidal Formula.

223. I. Averaging End Areas.



Let A_0 = area of cross-section at Station 0
A_1 = " " " " " " 1
l = length of section, Sta. 0 to Sta. 1
V = volume of section of earthwork (Sta. 0 to 1)

Then $V = \frac{A_0 + A_1}{2} l$ (in cubic feet) (158)

$= \frac{A_0 + A_1}{2} \cdot \frac{l}{27}$ (in cubic yards) (159)

As (158) is capable of expression $V = A_0 \frac{l}{2} + A_1 \frac{l}{2}$

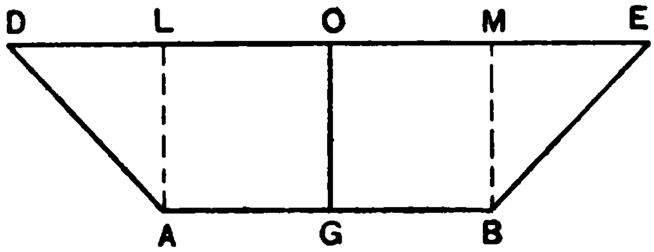
it is practically based on the assumption that the volume consists of two prisms, one of base A_0 and one of base A_1, and each of a length, or altitude of $\frac{l}{2}$.

224. To use this method, we must find the area A of each cross-section; the cross-section may be: —

(*a*) *Level.* (*b*) *Three-Level.* (*c*) *Five-Level.* (*d*) *Irregular.*

225. (*a*) **Level Cross-Section.**

Let $\quad b = \text{base} = \mathsf{AB} \qquad s = \text{side slope} = \dfrac{\mathsf{DL}}{\mathsf{AL}} = \dfrac{\mathsf{EM}}{\mathsf{BM}}$



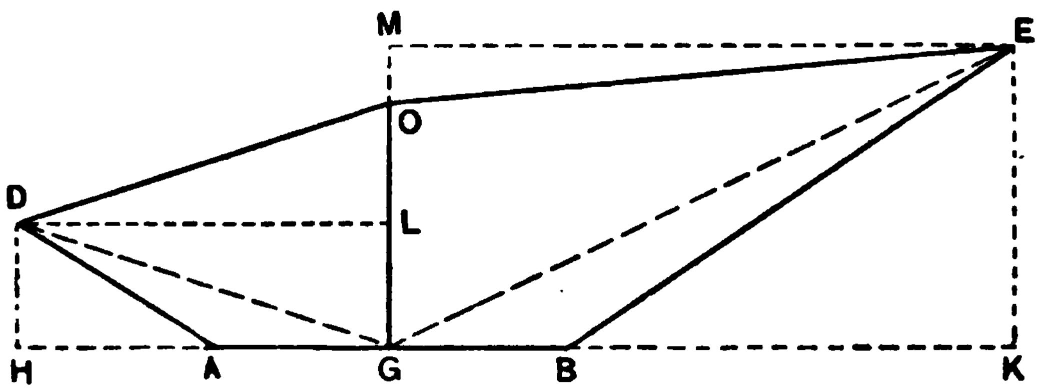
$c = \text{center ht.} = \mathsf{OG}$

$A = \text{area of cross-section}$

Then $\mathsf{DL} = \mathsf{EM} = sc$

$$\begin{aligned} A &= \mathsf{AB} \times \mathsf{OG} + \mathsf{DL} \times \mathsf{AL} \\ &= bc + sc^2 \\ &= c(b + sc) \qquad (160) \end{aligned}$$

226. (*b*) **Three-Level Section.** First Method.



Let $\quad b = \text{base} = \mathsf{AB} \qquad s = \text{side slope}$

$c = \text{center height}$

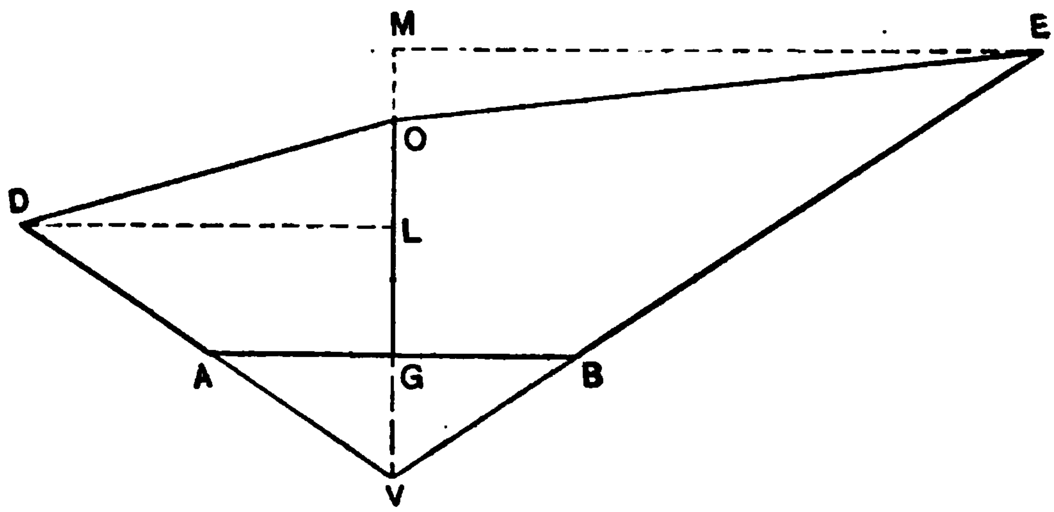
$h_r = \text{side height } \mathsf{EK} \qquad h_l = \text{side height } \mathsf{DH}$

$d_r = \text{distance out } \mathsf{ME} \qquad d_l = \text{distance out } \mathsf{DL}$

$A = \text{area of cross-section}$

Then
$$\begin{aligned} A &= \mathsf{OGD} + \mathsf{OGE} + \mathsf{GBE} + \mathsf{AGD} \\ &= \tfrac{1}{2}\mathsf{OG} \times \mathsf{DL} + \tfrac{1}{2}\mathsf{OG} \times \mathsf{ME} + \tfrac{1}{2}\mathsf{GB} \times \mathsf{EK} + \tfrac{1}{2}\mathsf{AG} \times \mathsf{DH} \\ &= \tfrac{1}{2} c(d_l + d_r) + \tfrac{1}{2}\frac{b}{2}(h_r + h_l) \\ &= \frac{c(d_l + d_r) + \dfrac{b}{2}(h_l + h_r)}{2} \qquad (161) \end{aligned}$$

227. (*b*) Three-Level Section. Second Method.



Using the same notation.

$$\frac{GB}{GV} = s$$

$$GV = \frac{GB}{s} = \frac{b}{2s}$$

$$OV = c + GV = c + \frac{b}{2s}$$

The triangle ABV is often called the "Grade Triangle."

$$\text{Area } ABV = GV \times GB$$

$$= \frac{b^2}{4s}$$

$$\text{Area } EODV = OV \times \frac{DL}{2} + OV \times \frac{ME}{2}$$

$$= \left(c + \frac{b}{2s}\right)\frac{d_l + d_r}{2}$$

$$A = EODV - ABV$$

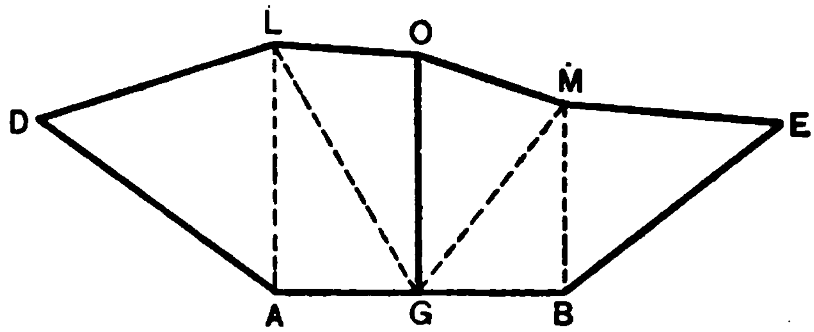
$$= \left(c + \frac{b}{2s}\right)\frac{d_l + d_r}{2} - \frac{b^2}{4s}$$

Let $$D = d_l + d_r$$

$$A = \left(c + \frac{b}{2s}\right)\frac{D}{2} - \frac{b^2}{4s} \qquad (162)$$

In using this formula for a *series* of cross-sections of the same base and slope, $\frac{b}{2s}$ and $\frac{b^2}{4s}$ are constants, and the computation of A becomes simple and more rapid than the first method.

228. (*c*) **Five-Level Section.**



Use notation the same as before ; in addition let

$$f_r = \text{height MB} ; \qquad f_l = \text{height LA}$$

Then $$A = \text{LGM} + \text{EMGB} + \text{DLGA}$$

$$= \frac{cb}{2} + \frac{f_r d_r}{2} + \frac{f_l d_l}{2}$$

$$A = \frac{cb + f_r d_r + f_l d_l}{2} \tag{163}$$

229. (*d*) **Irregular Section.**

The "Irregular Section," as shown in the figure, may be divided into trapezoids by vertical lines, as in Fig. 1 ; or into triangles by vertical and diagonal lines, as in Fig. 2.

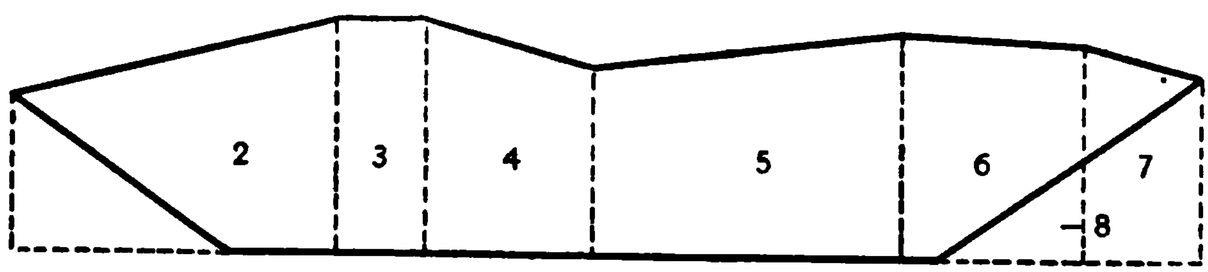


FIG. 1.

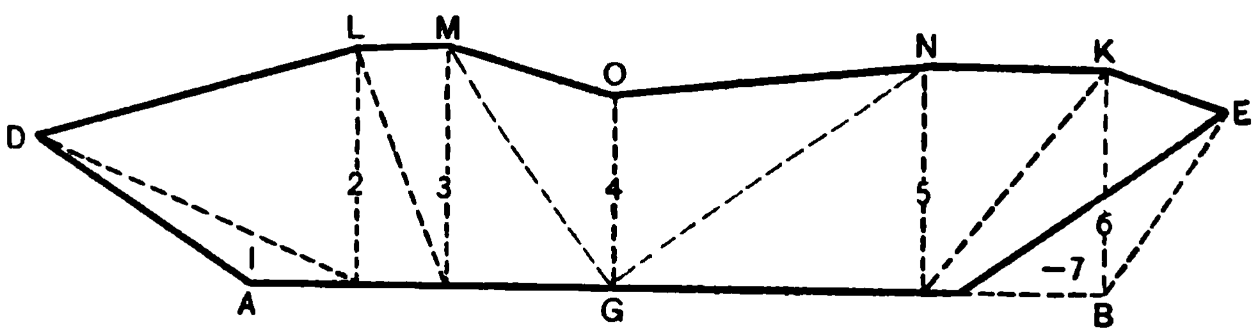


FIG. 2.

The triangles in Fig. 2 can be computed in groups of two, each pair having a common base (vertical). It will be seen that Fig. 1 requires 8 solutions and Fig. 2 only 7 solutions of trape-

zoids or triangles. The computations can be made in either case, after a little experience, directly from the notes without any necessity for a sketch.

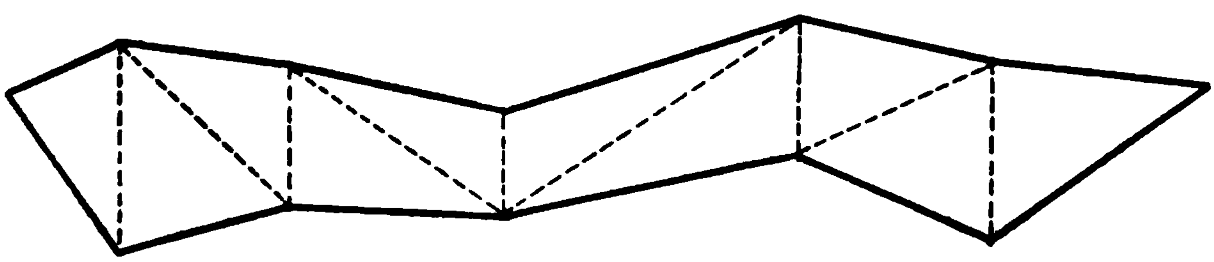
In Fig. 2 let OG = c = center cut

h_2, d_2 refer to point L

h_3, d_3 " " " M, etc.

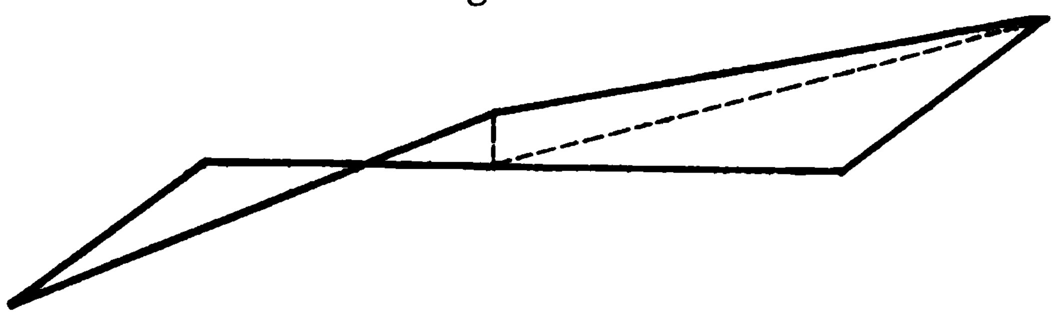
Then
$$A = \frac{c(d_3 + d_5)}{2} + \frac{h_3 d_2}{2} + \frac{h_2(d_l - d_3)}{2} + \frac{h_l\left(\frac{b}{2} - d_2\right)}{2}$$
$$+ \frac{h_5 d_6}{2} + \frac{h_6(d_r - d_5)}{2} - \frac{h_r\left(d_6 - \frac{b}{2}\right)}{2}$$

In the sections shown above, the base has been the regular base of roadbed, common to both regular and irregular sections. It may often happen that it will be necessary to take sections which are altogether irregular, perhaps with a base of irregular width and not in the form of a plane surface, as in the figure immediately below.



Such sections can almost always be divided into triangles and into pairs of triangles, and computed very much as is done in the case of Fig. 2 above.

A common form of section is one where part is in cut and part in fill as shown in the figure below.



This section also may be considered a special case of Irregular Section, and divided into convenient triangles, and into pairs of triangles so far as is feasible.

230. Another method which has been used for calculating irregular cross-sections is to plat them on cross-section paper, and get the area by "*Planimeter.*" In very irregular cross-sections this method would prove economical as compared with direct computation by ordinary methods, but it is probable that in almost every case equal speed and equal precision can be obtained by the use of suitable tables or diagrams (to be explained later); for this reason the use of the planimeter is not recommended, certainly where diagrams are available.

231. Whatever may be the form of section, or whatever the method of computation, having found the values of A for each cross-section, the volume V is found for the End Area Method, by the formula above given.

$$V = \frac{A_0 + A_1}{2} \cdot \frac{l}{27} \text{ (in cu. yds.)} \qquad (159)$$

It is found that this formula is only approximately correct. Its simplicity and *substantial accuracy* in the majority of cases render it so valuable that it has become the formula in most common use. It gives results, in general, larger than the true solidity.

232. II. Prismoidal Formula.

"A prismoid is a solid having for its two ends any dissimilar parallel plane figures of the same number of sides, and all the sides of the solid plane figures also."

Any prismoid may be resolved into prisms, pyramids, and wedges, having as a common altitude the perpendicular distance between the two parallel end planes.

Let A_0 and A_1 = areas of end planes.

M = area of middle section parallel to the end planes.

l = length of prismoid, or perpendicular distance between end planes.

V = volume of the prismoid.

Then it may be shown that

$$V = (A_0 + 4\,M + A_1)\frac{l}{6}$$

233. Let B = area of lower face, or base of a prism, wedge, or pyramid.

b = area of upper face.

m = middle area parallel to upper and lower faces.

a = altitude of prism, wedge, or pyramid.

s = solidity " " " " "

Then the area of the *upper face* b in terms of *lower base* B will be for

Prism	Wedge	Pyramid
$b = B$	$b = 0$	$b = 0$

and the *middle area* m will be for

Prism	Wedge	Pyramid
$m = B$	$m = \frac{B}{2}$	$m = \frac{B}{4}$

The solidity s will be for

Prism

$$s = aB = \frac{a}{6} \cdot 6\,B = \frac{a}{6}(B + 4\,B + B) = \frac{a}{6}(B + 4\,m + b)$$

Wedge

$$s = \frac{aB}{2} = \frac{a}{6} \cdot 3\,B = \frac{a}{6}\left(B + \frac{4\,B}{2} + 0\right) = \frac{a}{6}(B + 4\,m + b)$$

Pyramid

$$s = \frac{aB}{3} = \frac{a}{6} \cdot 2\,B = \frac{a}{6}\left(B + \frac{4\,B}{4} + 0\right) = \frac{a}{6}(B + 4\,m + b)$$

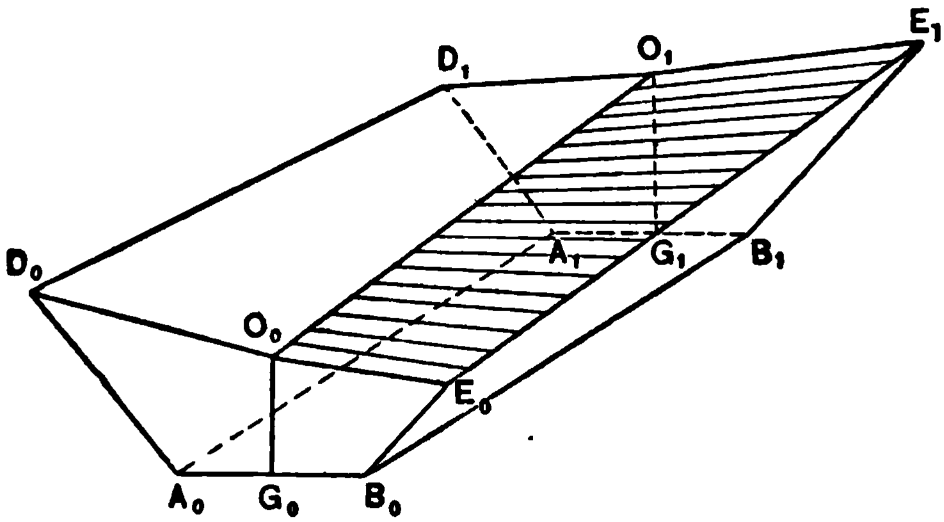
Since a prismoid is composed of prisms, wedges, and pyramids, the same expression may apply to the prismoid, and this may be put in the general form

$$V = (A_0 + 4\,M + A_1)\frac{l}{6} \tag{163 A}$$

using the notation of the preceding page.

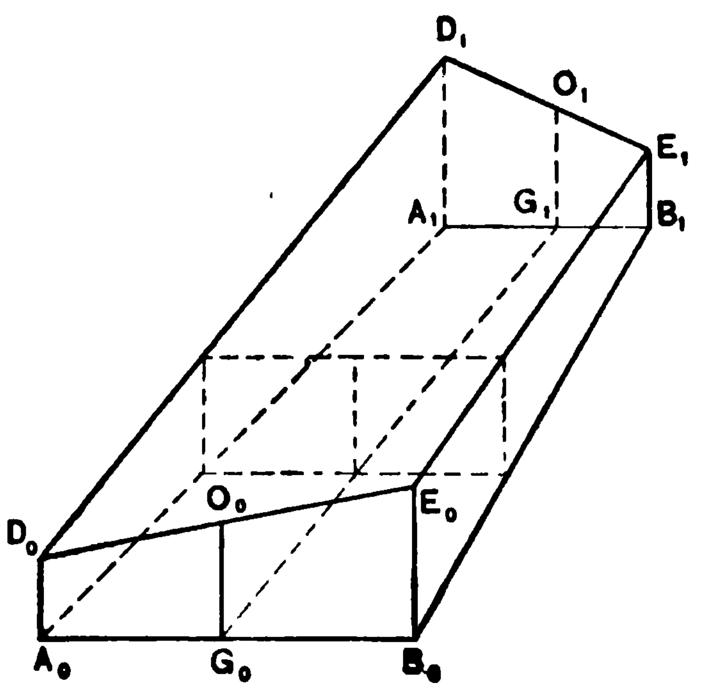
234. A regular section of earthwork having for its surface a plane face is a prismoid. Most sections of earthwork have not their surface plane, and are not strictly prismoids, although they are so regarded by some writers.

In this figure the lines E_0O_0 and E_1O_1 are not parallel, and therefore the surface $O_0O_1E_1E_0$ is not a plane. The most common assumption as to this surface is that the lines O_0O_1 and E_0E_1 are right lines, and that the surface $O_0O_1E_1E_0$ is a warped surface, generated by a right line moving as a generatrix always



parallel to the plane $O_0G_0B_0E_0$ and upon the lines O_0O_1 and E_0E_1 as directrices, as indicated in the figure. The surface thus generated is a warped surface called a "hyperbolic paraboloid." It will be shown that the "prismoidal formula" applies also to this solid, which is not, however, properly a prismoid.

235. In the following figure, which has perpendicular sides $D_0A_0A_1D_1$, $E_0B_0B_1E_1$ and the lines D_0E_0 and D_1E_1 right lines,



let $b_0 =$ base $= A_0B_0$

$b_1 =$ " $= A_1B_1$

$c_0 =$ center ht. $= O_0G_0$

$= \dfrac{D_0A_0 + E_0B_0}{2}$

$c_1 =$ center ht. $= O_1G_1$

$= \dfrac{D_1A_1 + E_1B_1}{2}$

$l =$ length (altitude) of section $= G_0G_1$

$A_0 =$ area of $D_0A_0B_0E_0$

$A_1 =$ area of $D_1A_1B_1E_1$

$V =$ volume

Also use notation b_x, c_x, A_x for a section distant x from G_1.

Then

$$A_0 = b_0c_0 \qquad A_1 = b_1c_1$$

$$b_x = b_1 + (b_0 - b_1)\frac{x}{l}$$

$$c_x = c_1 - (c_1 - c_0)\frac{x}{l} = c_1 + (c_0 - c_1)\frac{x}{l}$$

$$A_x = b_xc_x = \left[b_1 + (b_0 - b_1)\frac{x}{l}\right]\left[c_1 + (c_0 - c_1)\frac{x}{l}\right]$$

$$V = \int_0^l \left[b_1 + (b_0 - b_1)\frac{x}{l}\right]\left[c_1 + (c_0 - c_1)\frac{x}{l}\right]dx$$

$$= b_1c_1l + [b_1(c_0 - c_1) + c_1(b_0 - b_1)]\frac{l^2}{2l} + \frac{(b_0 - b_1)(c_0 - c_1)l^3}{3l^2}$$

$$= \frac{l}{6}\left\{\begin{array}{l} 6\,b_1c_1 + 3\,b_1c_0 + 3\,b_0c_1 + 2\,b_0c_0 \\ -\,3\,b_1c_1 - 2\,b_1c_0 - 2\,b_0c_1 \\ -\,3\,b_1c_1 \\ +\,2\,b_1c_1 \end{array}\right\}$$

$$V = \frac{l}{6}(2\,b_1c_1 + 2\,b_0c_0 + b_1c_0 + b_0c_1) \qquad (164)$$

236. Apply the "Prismoidal Formula" to the same section. The base and center height of the middle section are :—

$$b_m = \frac{b_0 + b_1}{2} \qquad c_m = \frac{c_0 + c_1}{2}$$

$$A_0 = b_0c_0 \qquad A_1 = b_1c_1$$

$$M = \frac{b_0 + b_1}{2} \times \frac{c_0 + c_1}{2} = \text{area of middle section}$$

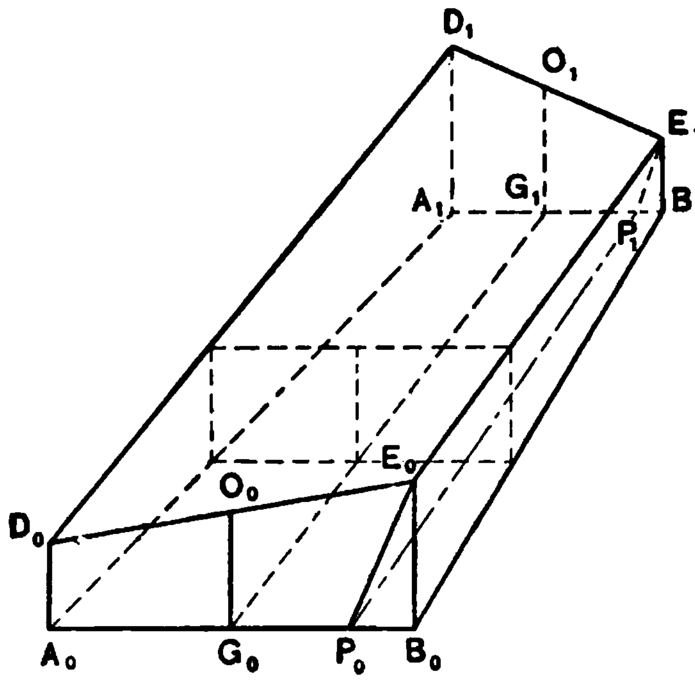
$$V = \frac{l}{6}(A_0 + 4\,M + A_1)$$

$$= \frac{l}{6}\,(b_0c_0 + b_0c_0 + b_0c_1 + b_1c_0 + b_1c_1 + b_1c_1)$$

$$= \frac{l}{6}(2\,b_1c_1 + 2\,b_0c_0 + b_1c_0 + b_0c_1) \qquad (165)$$

This is the same as formula (164) found above to be correct for the warped surface. Therefore the "Prismoidal Formula" (163 A) applies to the section shown in § 235.

237. The sections of earthwork commonly used in railroad work are bounded not by perpendicular sides, but by inclined planes.



In the figure, suppose a plane to be passed through the line E_0E_1, cutting A_0B_0 at P_0 and A_1B_1 at P_1. The prismoidal formula applies to the solid $E_0P_0B_0B_1E_1P_1$ cut out by this plane, since this solid is a true prismoid. If the prismoidal formula applies to the entire solid, and also to the part cut out, it must apply to the remaining solid $D_0A_0P_0E_0E_1P_1A_1D_1$, and this represents in form one side of a regular three-level section of earthwork in which D_0A_0 represents the center height and E_0P_0 the slope.

If the prismoidal formula applies to the section upon one side of the center, it applies also to the other side, and so to the entire section.

238. The "*Prismoidal Formula*" is of wide application. Since it applies to prisms, wedges, pyramids, and to solids bounded by warped surfaces generated as described, it follows that it applies to any solid bounded by two parallel plane faces and defined by the surfaces generated by a right line moving upon the perimeters of these faces as directrices. It may also be stated here without demonstration that it also applies to the *frusta* of all solids generated by the revolution of a conic section as well as to the complete solids, for instance, the sphere.

The prismoidal formula is generally accepted as correct for the computation of earthwork and similar solids, and the measurements of a section of earthwork are taken so as to represent properly the surface of the ground if this be a warped surface of the sort described. The failure to use the prismoidal formula is explained often by the additional labor necessary for its use.

239. For "three-level" sections of earthwork, a result correct by the prismoidal formula may be secured, and the work simplified, by calculating the quantities first by the inexact method of "end areas," and then applying a *correction* which we may call "**The Prismoidal Correction.**"

Let V_e = solidity by end areas

V_p = " " prismoidal formula

Then $C = V_e - V_p$ = prismoidal correction

In the figure, § 235,

$$V_p = \text{by formula (164)} = \frac{l}{6}(2\,b_1c_1 + 2\,b_0c_0 + b_1c_0 + b_0c_1)$$

$$V_e = \frac{l}{2}\,(b_1c_1 + b_0c_0) \quad = \frac{l}{6}(3\,b_1c_1 + 3\,b_0c_0)$$

$$C = V_e - V_p = \frac{l}{6}\,(b_1c_1 + b_0c_0 - b_1c_0 - b_0c_1)$$

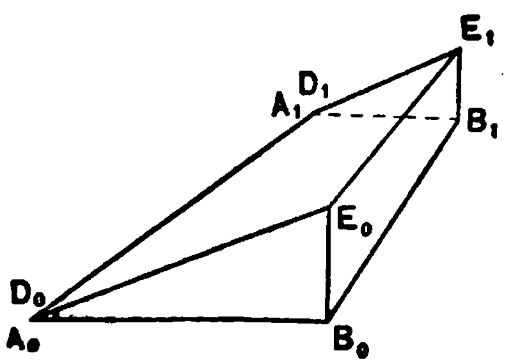
$$= \frac{l}{6}\,(b_1 - b_0)(c_1 - c_0)$$

Let $\quad D_0A_0 = h_0' \qquad D_1A_1 = h_1'$

$\qquad E_0B_0 = h_0 \qquad E_1B_1 = h_1$

Then
$$C = \frac{l}{6}\,(b_1 - b_0)\left(\frac{h_1 + h_1'}{2} - \frac{h_0 + h_0'}{2}\right)$$

$$= \frac{l}{12}(b_1 - b_0)\,(h_1 + h_1' - h_0 - h_0')$$

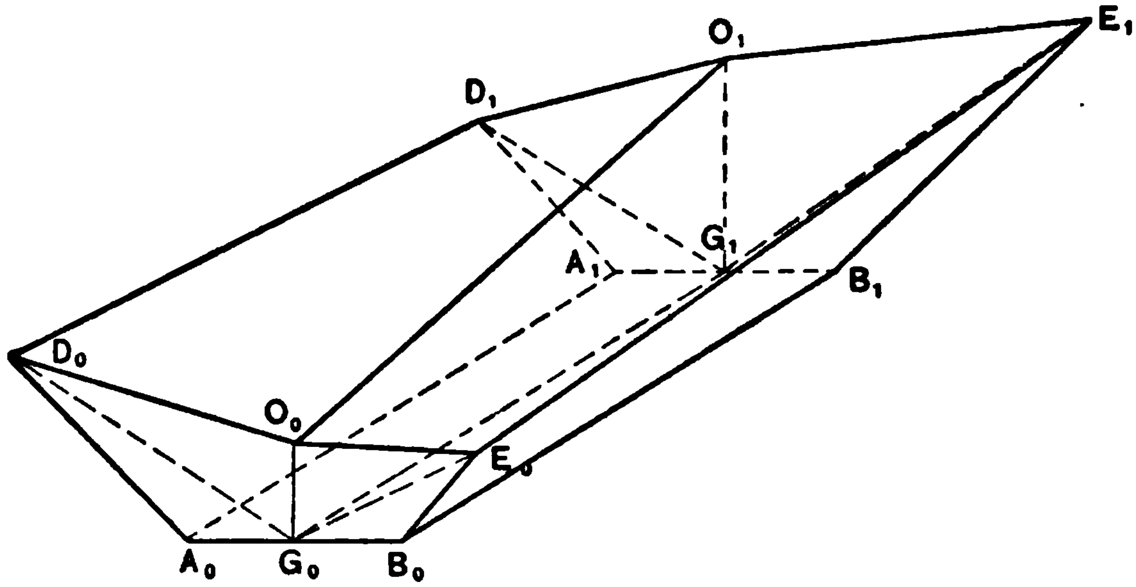


When the solid assumes a triangular cross-section, as in the figure,

$h_0' = 0 \qquad h_1' = 0$

$$C = \frac{l}{12}(b_1 - b_0)(h_1 - h_0) \quad (166)$$

240. If any solid be divided into a number of solids each of triangular cross-section, the above correction may be applied to each such triangular solid, and the sum of the corrections will be the correction for the entire solid.



Let this figure represent a section of earthwork divided into three parts, as indicated by the lines D_0G_0, E_0G_0, D_1G_1, E_1G_1.

Then, for the solid $O_0D_0G_0E_0E_1G_1D_1O_1$,

$$C = \frac{l}{12}[(c_1 - c_0)(d_{l_1} - d_{l_0}) + (c_1 - c_0)(d_{r_1} - d_{r_0})]$$

$$= \frac{l}{12}(c_1 - c_0)(d_{l_1} + d_{r_1} - d_{l_0} - d_{r_0})$$

Let $D_1 = d_{l_1} + d_{r_1}$ and $D_0 = d_{l_0} + d_{r_0}$

$$C = \frac{l}{12}(c_1 - c_0)(D_1 - D_0)$$

For the solid $G_0B_0E_0E_1B_1G_1$,

$$C = \frac{l}{12}\left(\frac{b_1}{2} - \frac{b_0}{2}\right)(h_{r_1} - h_{r_0}) \tag{166}$$

$$= \frac{l}{12}(0)(h_{r_1} - h_{r_0})$$

$$= 0$$

Similarly for the solid $A_0G_0D_0D_1G_1A_1$.

Hence for the entire solid $A_0B_0E_0O_0D_0D_1O_1E_1B_1A_1$.

$$C = \frac{l}{12}(c_1 - c_0)(D_1 - D_0) \tag{167}$$

When $l = 100$

$$C_{100} = \frac{100}{12 \times 27}(c_1 - c_0)(D_1 - D_0)$$

$$= \frac{1}{3.24} \quad (c_1 - c_0)(D_1 - D_0) \text{ in cu. yds.} \qquad (168)$$

Since $\quad C = V_e - V_p, \qquad V_p = V_e - C \qquad (169)$

When $(c_1 - c_0)(D_1 - D_0)$ is *positive*, the correction C is to be *subtracted* from V_e.

When $(c_1 - c_0)(D_1 - D_0)$ is *negative*, the arithmetical value of C is to be *added* to V_e. The latter case seldom occurs in practice, except where C is very small, perhaps small enough to be neglected.

For the purposes of the prismoidal correction it should be borne in mind that the signs + or − mean simply *cut* or *fill*, and *should not be considered* in determining whether to add or subtract the correction.

For a section of length l, $\quad C_l = \frac{l}{100} C_{100}$

$$V_{pl} = \frac{l}{100}(V_{e100} - C_{100}) \qquad (169\ A)$$

The prismoidal correction has two principal forms. For a solid bounded by ends of triangular section the form is

$$C = \frac{l}{12}(b_1 - b_0)(h_1 - h_0) \qquad (166)$$

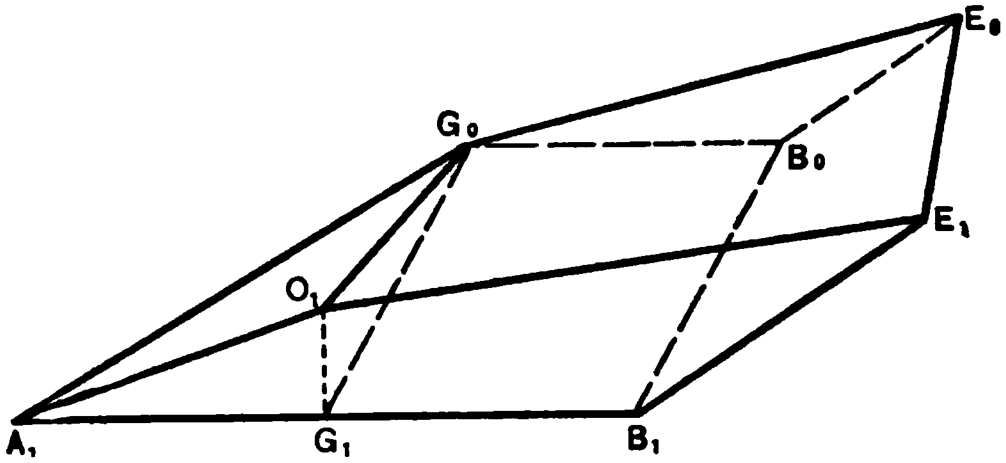
This should be considered the fundamental form. In the case of regular "Three Level Sections" it takes a secondary or special form

$$C = \frac{l}{12}(c_1 - c_0)(D_1 - D_0) \qquad (167)$$

This last formula can be used only when the width of base is the same at both ends of the section. From the method of its derivation it is evident that for the right half of a regular three level section

$$C_r = \frac{l}{12}(c_1 - c_0)(d_{r_1} - d_{r_0}) \qquad (167\ A)$$

241. In passing from cut to fill as in the figure

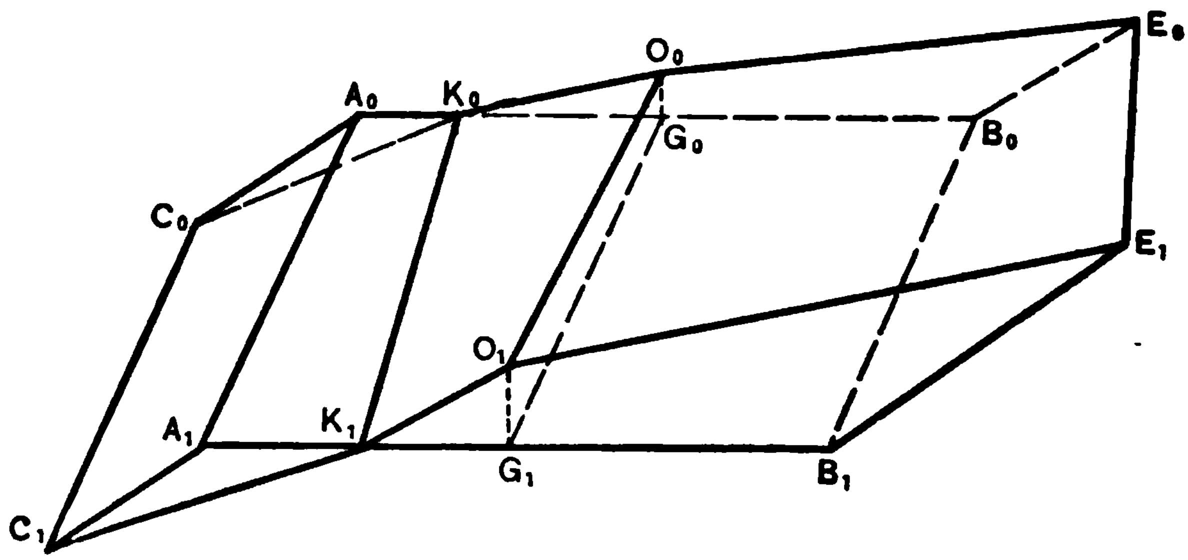


for the right half $\quad C_r = \frac{l}{12}(c_1 - c_0)(d_{r_1} - d_{r_0})$ from (167 *A*)

for the left side $\quad C_l = \frac{l}{12}(c_1 - c_0)\left(\frac{b}{2} - 0\right)$ from (166)

$$C = \frac{l}{12}(c_1 - c_0)(D_1 - d_{r_0})$$

For the special case of a side hill section



the prismoidal correction for cut will be

$$C_c = \frac{l}{12}(c_1 - c_0)(d_{r_1} + d_{k_1} - \overline{d_{r_0} + d_{k_0}})$$

the prismoidal correction for fill will be

$$C_f = \frac{l}{12}\left(h_{l_1} - h_{l_0}\right)\left(\frac{b}{2} - d_{k_1} - \overline{\frac{b}{2} - d_{k_0}}\right)$$

$$= \frac{l}{12}(h_{l_1} - h_{l_0})(d_{k_0} - d_{k_1})$$

242. Formula (166) can also be used to find the correction for the triangular pyramids (for excavation Sta. 2+76 to 2+87, and embankment 2 + 64 to 2 + 76), *each end of the pyramid* being considered to have a triangular section. A much simpler way to find the correction for a pyramid is this,

$$C = V_e - V_p = \frac{1}{3} V_e$$

as may readily be shown to be true for any pyramid, since

$$V_e = A\frac{l}{2}$$

$$V_p = A\frac{l}{3}$$

$$C = V_e - V_p = A\frac{l}{6} \qquad (170)$$

since by the End Area method $V_e = A\frac{l}{2} + 0$

$$C = \frac{V_e}{3} \qquad (171)$$

243. In the case of regular "**Five-Level Sections,**" as shown in the figure, p. 152, the prismoidal correction may be computed for each of the triangular masses bounded by

1. LGM 2. MEBG 3. LDAG

In the case of LGM, the prismoidal correction will evidently be $= 0$, since $D_0 = \text{AB} = D_1$, and therefore $D_0 - D_1 = 0$.

The correction for the mass bounded on one end by

$$\text{MEBG} = C = \frac{l}{12}(f_{r_0} - f_{r_1})(d_{r_0} - d_{r_1}) \qquad \text{from (166)}$$

and by $$\text{LDAG} = C = \frac{l}{12}(f_{l_0} - f_{l_1})(d_{l_0} - d_{l_1}) \qquad \text{from (166)}$$

244. In the case of "**Irregular Sections,**" the prismoidal correction cannot with convenience be accurately employed. There are, however, several methods by which we may calculate a "prismoidal correction" which will be approximately correct, and good enough for practical purposes.

Inspection of the formula $C = \frac{l}{12}(c_1 - c_0)(D_1 - D_0)$ (167) makes it clear that the correction will be large when the two end sections differ much in size, and small when the end sections are nearly equal. Ordinarily in a large section both c and D are large. For any *given area of section* in a regular three-level section, if c is made smaller, D must be increased in nearly like measure, and formula (167) will show little change in the value of C even if c be changed, if the area remains the same.

For the purpose *only* of finding the prismoidal correction there are several approximate methods based on the principle above stated.

1. Where the section is only slightly irregular. Neglect all intermediate heights and figure correction from c and D. This is a very simple method.

Where more careful results seem desirable,

2. Find c and D for an "equivalent level section"; that is, a level section of equal area to the irregular section. Use the c and D thus determined in computing the prismoidal correction. These can be used with the c and D of a regular three-level section, or with the c and D of another equivalent level section.

The c and D of the equivalent level section may be found from Tables or from Diagrams, whose use will be shown in later chapters.

3. Find an equivalent regular three-level section (not level) either by

(*a*) retaining c and computing D, or

(*b*) retaining D and computing c.

The method of doing this will be made simple by Diagrams described in a later chapter.

4. Plot the irregular section on cross-section paper, and draw lines to form a regular three-level section which will closely approximate, in form, to the irregular section, and find c and D.

While the results obtained by any of the above methods are approximate, the resulting error can be only a small fraction of the entire correction, which is itself small.

The method of averaging end areas and applying the prismoidal correction allows of great rapidity, and secures great precision, and well meets the requirements of modern railroad practice.

CHAPTER XIII.

SPECIAL PROBLEMS.

245. Correction for Curvature.

In the case of a curve, the ends of a section of earthwork are not parallel, but are in each case normal to the curve. In calculating the solidity of a section of earthwork, we have heretofore assumed the ends parallel, and for curves this is equivalent to taking them perpendicular to the chord of the curve between the two stations.

Then, as shown in Fig. 1 (where IG and GT are center-line chords), the solidity (as above) of the sections IG and GT will be too great by the wedge-shaped mass RGP, and too small by

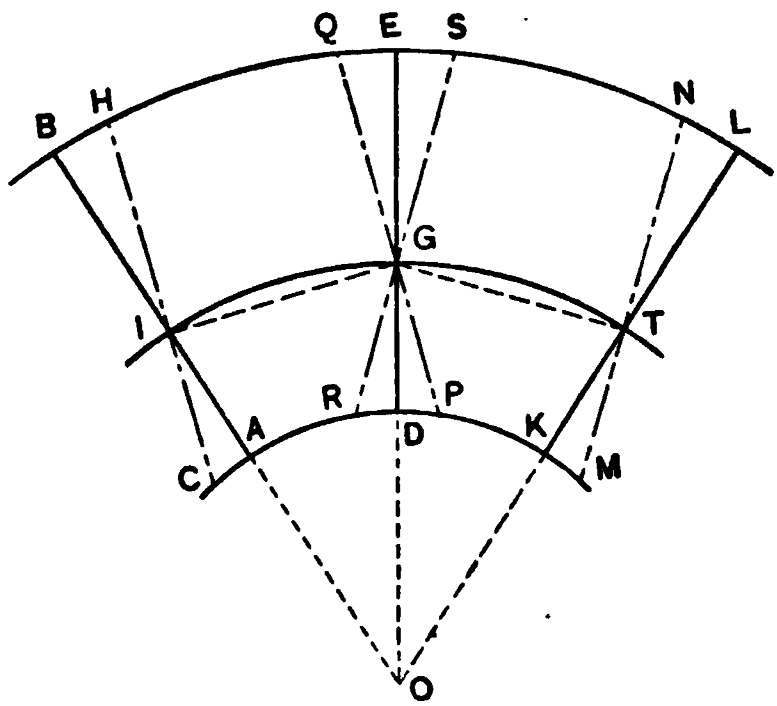


Fig. 1.

QGS. When the cross-sections on each side of the center are equal, these masses balance each other. When the cross-section on one side differs much in area from that on the other, the correction necessary may be considerable.

In Fig. 2, use c, h_l, h_r, d_l, d_r, b, s, as before.

Let D = degree of curve. Make BL = AD, and join OL.

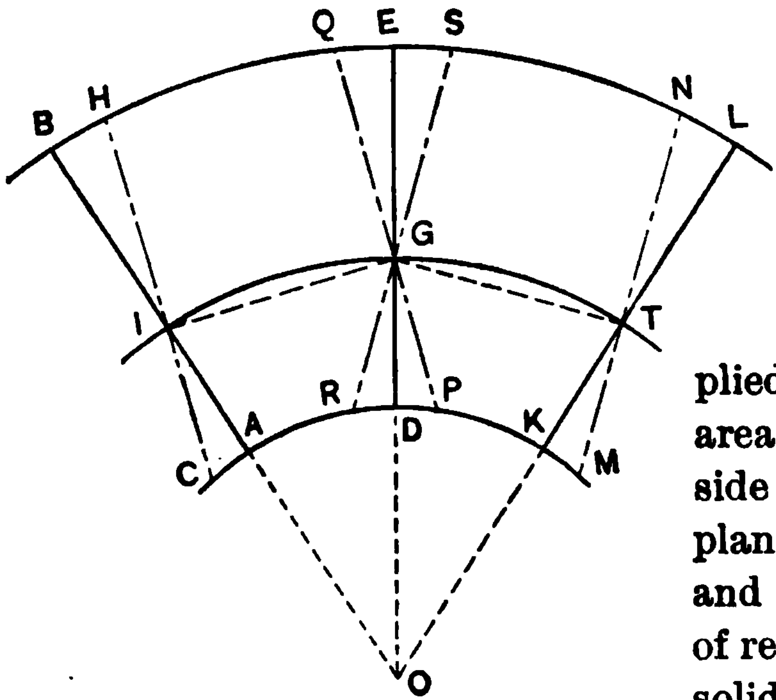


FIG. 1.

Then ODAG balances OLBG, and there remains an unbalanced area OLE.

Draw OKP parallel to AB.

By the "Theorem of Pappus" (see Lanza, Applied Mechanics), "If a plane area lying wholly on the same side of a straight line in its own plane revolves about that line, and thereby generates a solid of revolution, the volume of the solid thus generated is equal to the product of the revolving area and of the path described by the center of gravity of the plane area during the revolution."

The correction for curvature, or the solidity, developed by this triangle OLE (Fig. 2) revolving about OG as an axis will be its area × the distance described by its center of gravity. The distance out (horizontal) to the center of gravity from the axis (center line) will be two thirds of the mean of the distances out to E and to L, or

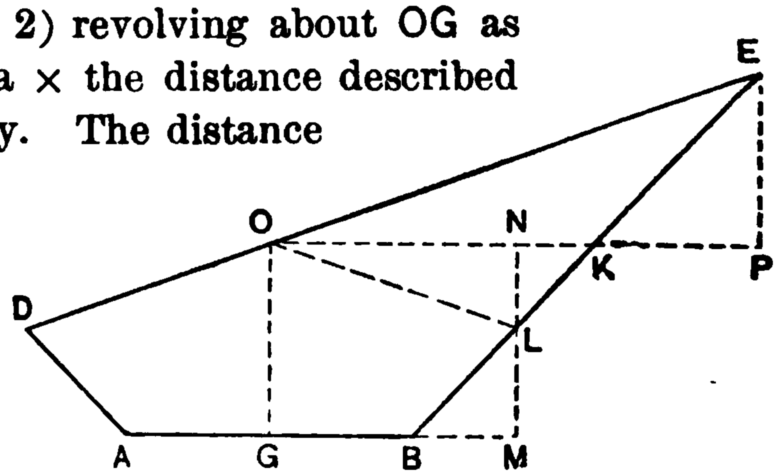


FIG. 2.

$$= \frac{2}{3} \cdot \frac{d_l + d_r}{2}$$

and the distance described will be

$$\frac{2}{3} \cdot \frac{d_l + d_r}{2} \times \text{angle QGS}$$

The area $\qquad \text{OLE} = \text{OK} \times \dfrac{\text{NL} + \text{PE}}{2}$

$$= \left(\frac{b}{2} + sc\right) \frac{h_r - h_l}{2}$$

Therefore the correction for curvature,

$$C=\left(\frac{b}{2}+sc\right)\cdot\frac{h_r-h_l}{2}\cdot\frac{d_r+d_l}{3}\times \text{angle QGS}$$

When IG, GT are each a full station, or 100 ft. in length,

$$\text{QGS}=D$$

$$C=\left(\frac{b}{2}+sc\right)\cdot\frac{h_r-h_l}{2}\cdot\frac{d_r+d_l}{3}\times \text{angle } D$$

arc $1^\circ = .01745$

$$C=\left(\frac{b}{2}+sc\right)\frac{h_r-h_l}{2}\times\frac{d_r+d_l}{3}\times 0.01745\,D$$

$$=\left(\frac{b}{2}+sc\right)(h_r-h_l)(d_r+d_l)\times 0.00291\,D \text{ (cu. ft.)} \qquad (172)$$

$$=\left(\frac{b}{2}+sc\right)(h_r-h_l)(d_r+d_l)\times 0.00011\,D \text{ (cu. yds.)} \qquad (173)$$

246. When IG or GT, or both, are less than 100 ft., let

$$\text{IG}=l_0 \qquad \text{and} \qquad \text{GT}=l_1$$

Then $\qquad \text{QGE}=\frac{l_0}{100}\times\frac{D}{2}$ and $\text{SGE}=\frac{l_1}{100}\times\frac{D}{2}$

$$\text{QGS}=\frac{l_0+l_1}{200}D$$

$$C=\left(\frac{b}{2}+sc\right)(h_r-h_l)(d_r+d_l)\frac{l_0+l_1}{200}\times 0.00011\,D \text{ (cu. yds.)} \quad (174)$$

247. The correction C is to be added when the greater area is on the outside of the curve, and subtracted when the greater area is on the inside of the curve. When the center height is 0, as in Fig. 3, we may consider this a regular section in which $c=0$, $h_l=0$, and $d_l=\frac{b}{2}$; then

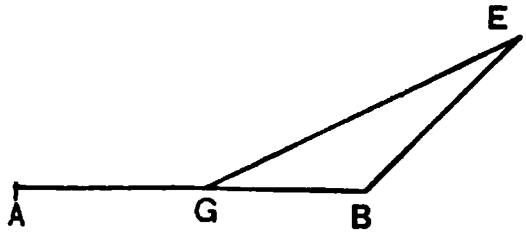


FIG. 3.

$$C=\frac{b}{2}\times h_r\times\left(d_r+\frac{b}{2}\right)\frac{l_0+l_1}{200}\times 0.00011\,D \text{ (cu. yds.)} \qquad (175)$$

In the case of an irregular section, as shown in Fig. 4, the area and distance to center of gravity (for example, of OHEML) may be found by any method available, and the correction

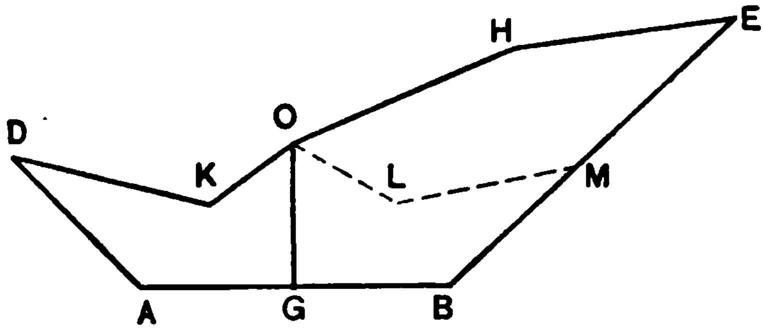
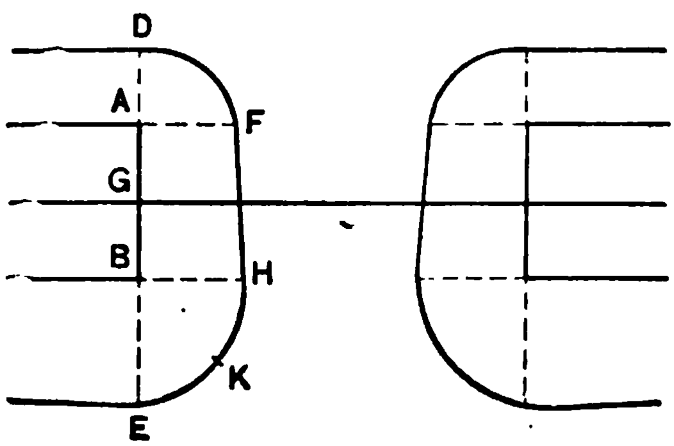


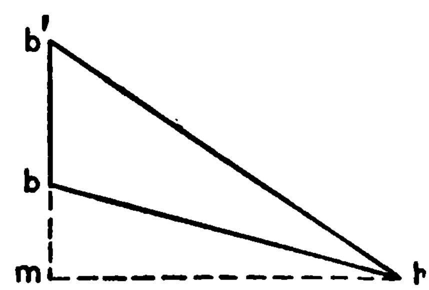
FIG. 4.

figured accordingly. The correction for curvature is, in present railroad practice, more frequently neglected than used. Nevertheless, its amount is sufficient in many cases to fully warrant its use.

248. Opening in Embankment.

Where an opening is left in an embankment, there remains outside the regular sections the mass DEKHF.





This must be calculated in 3 pieces, ADF, BEKH, ABHF.

Let b = base = AB

d_r = distance out right

d_l = distance out left

$\left.\begin{array}{l} p_r = \text{BH} \\ p_l = \text{AF} \end{array}\right\}$ taken parallel to center line

$\left.\begin{array}{l} f_r = \\ f_l = \end{array}\right\}$ heights at $\left\{\begin{array}{l} \text{B} \\ \text{A} \end{array}\right.$

s_1 = solidity ADF

s_2 = BEKH

s_3 = ABHF

Then (approximately) following the "Theorem of Pappus," s_1 = mean of triangular sections AD and AF $\times$ distance described by center of gravity.

In the quarter cone AFD, $\mathrm{AF} = p_l$

$$\mathrm{AD} = d_l - \frac{b}{2}$$

Then average radius $R_l = \mathrm{mh} = \dfrac{\mathrm{AF} + \mathrm{AD}}{2}$

Area of vertical triangular section $A_l = \dfrac{f_l R_l}{2}$

Distance from A to center of gravity of vertical section $= \dfrac{R_l}{3}$

Arc described by center of gravity $= \dfrac{R_l}{3} \times \dfrac{\pi}{2} = \dfrac{\pi R_l}{6}$

$$s_1 = \frac{f_l R_l}{2} \times \frac{\pi R_l}{6} \text{ (cu. ft.)}$$

$$= \frac{f_l R_l^2 \times 3.1416}{2 \times 6 \times 27} \text{ (cu. yds.)}$$

$$s_1 = 0.0097\, f_l R_l^2 \text{ (cu. yds.)} \qquad (176)$$

Similarly, in the quarter cone BEKH

The average radius $R_r = \dfrac{\mathrm{BH} + 2\,\mathrm{BK} + \mathrm{BE}}{4}$

$$s_2 = \frac{f_r R_r}{2} \times \frac{\pi R_r}{6} \text{ (cu. ft.)}$$

$$s_2 = 0.0097\, f_r R_r^2 \text{ (cu. yds.)} \qquad (177)$$

For the solid AGBHF

$$s_3 = \frac{\text{area AF} + \text{area BH}}{2} \times \mathrm{AB}$$

$$= \frac{(f_l p_l + f_r p_r) b}{4} \qquad (178)$$

The work of deriving formulas (176) and (177) is approximate throughout, but the total quantities involved are in general not large, and the error resulting would be unimportant.

There seems to be no method of accurately computing this solidity which is adapted to general railroad practice.

249. Borrow-Pits.

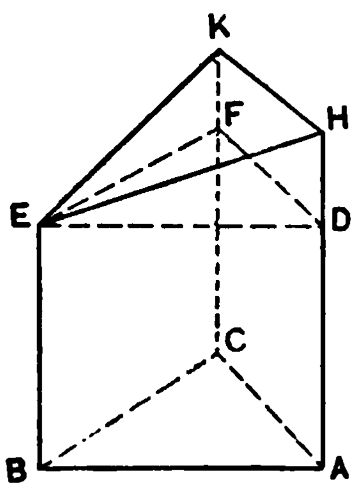
In addition to the ordinary work of excavation and embankment for railroads, earth is often "borrowed" from outside the limits of the work proper; and in such excavations called "borrow-pits," it is common to prepare the work by dividing the surface into squares, rectangles, or triangles, taking levels at every corner upon the original surface; again, after the excavation of the borrow-pit is completed, the points are reproduced and levels taken a second time. The excavation is thus divided into a series of vertical prisms having square, rectangular, or triangular cross-sections. These prisms are commonly truncated top and bottom. The lengths or altitudes of the vertical edges of these prisms are given by the difference in levels taken,

1st, on the original surface, and

2d, after the excavation is completed.

This method of measurement is very generally used, and for many purposes.

250. Truncated Triangular Prisms.



Let A = area of right section EFD of a truncated prism, the base ABC being a right section

h_1 = height AH

h_2 = " BE

h_3 = " CK

a = altitude of triangle EFD dropped from E to FD

Let V = volume of prism ABCKHE

s_l = solidity " " ABCFDE

s_u = " " pyramid FDEHK

Then $s_l = A \times \mathsf{AD} = A \times \frac{3\,\mathsf{AD}}{3} = A \times \frac{\mathsf{AD}+\mathsf{BE}+\mathsf{CF}}{3}$

$$s_u = \text{area } \mathsf{DFKH} \times \frac{a}{3}$$

$$= \frac{\mathsf{KF}+\mathsf{HD}}{2} \times \mathsf{FD} \times \frac{a}{3}$$

$$= \frac{\mathsf{KF}+\mathsf{HD}}{3} \times \mathsf{FD} \times \frac{a}{2}$$

$$= \frac{\mathsf{KF}+\mathsf{HD}}{3} \times A$$

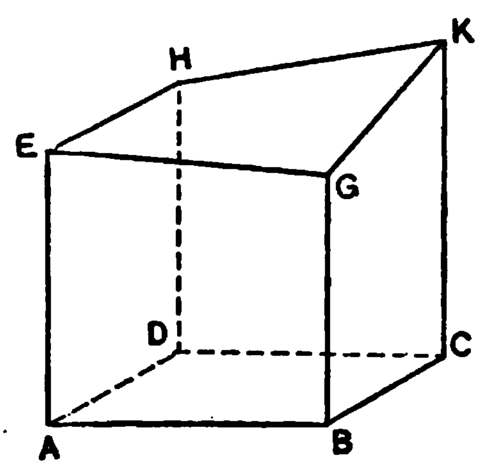
$$V = s_l + s_u = A\left(\frac{\mathsf{AD}+\mathsf{BE}+\mathsf{CF}}{3} + \frac{\mathsf{KF}+\mathsf{HD}}{3}\right)$$

$$= A\,\frac{(\mathsf{AD}+\mathsf{HD})+\mathsf{BE}+(\mathsf{CF}+\mathsf{KF})}{3}$$

$$= A\,\frac{h_1+h_2+h_3}{3} \qquad (179)$$

If the prism be truncated top and bottom, the same reasoning holds and the same formula applies.

251. Truncated Rectangular Prism.



Let A = area of right section ABCD of a rectangular prism truncated on top (base is ABCD)

h_1 = height AE

h_2 = " BG

h_3 = " KC

h_4 = " HD

V = volume of prism

b = AD = BC

a = AB = DC

Then using method of end areas,

$$V = \frac{\mathsf{AEHD} + \mathsf{BGKC}}{2} \times a$$

$$= \frac{b\dfrac{h_1 + h_4}{2} + b\dfrac{h_2 + h_3}{2}}{2} \times a$$

$$= ab\,\frac{h_1 + h_2 + h_3 + h_4}{4}$$

$$V = A\,\frac{h_1 + h_2 + h_3 + h_4}{4} \text{ (cu. ft.)} \qquad (180)$$

$$V = \frac{A}{27} \cdot \frac{h_1 + h_2 + h_3 + h_4}{4} \text{ (cu. yds.)} \qquad (181)$$

We may find V, correct by the prismoidal formula, if we apply the prismoidal correction. The prismoidal correction $C = 0$, since $D_0 - D_1 = 0$ (or in this case AD − BC = 0). The formula therefore remains unchanged. It is evident from this, then, that the solution holds good, and the formula is correct, not only when the surface EHKG is a plane, but also when it is a warped surface generated by a right line moving always parallel to the plane ADHE, and upon EG and HK as directrices.

Some engineers prefer to cross-section in rectangles of base 15′ × 18′. In this case

$$V = \frac{15' \times 18'}{27} \cdot \frac{h_1 + h_2 + h_3 + h_4}{4} \text{ (cu. yds.)}$$

$$= 10\,\frac{h_1 + h_2 + h_3 + h_4}{4} \text{ (cu. yds.)} \qquad (182)$$

Other convenient dimensions will suggest themselves, as

10′ × 13.5′ or 20′ × 13.5′ or 20′ × 27′

By this method the computations are rendered slightly more convenient; but the size of the cross-section, and the shape, whether square or rectangular, should depend on the topography. The first essential is accuracy in results, the second is simplicity and economy in field-work, and ease of computation should be subordinate to both of these considerations.

252. Assembled Prisms.

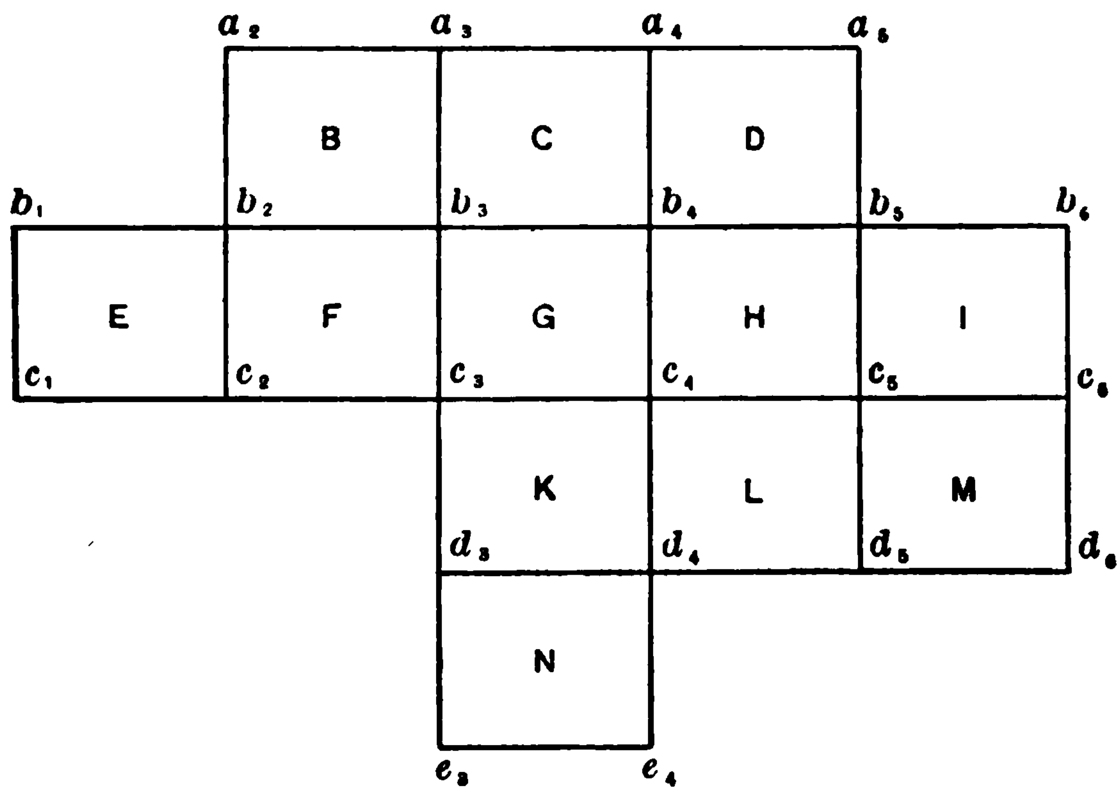
In the case of an assembly of prisms of equal base, it is not necessary to separately calculate each prism, but the solidity of a number of prisms may be calculated in one operation.

In the prism B,

$$V_B = A\frac{a_2 + a_3 + b_3 + b_2}{4}$$

$$V_C = A\frac{a_3 + a_4 + b_4 + b_3}{4}, \text{ etc.}$$

From inspection it will be seen, taking A as the common area of base of a single prism, and taking the sum of the solidities, that the heights a_2, a_5 enter into the calculation of



one prism only; a_3, a_4 into two prisms each; b_1, b_6 one only; b_2, b_5 into three prisms; b_3, b_4 into four prisms; and similarly throughout.

Let t_1 = sum of heights common to one prism
t_2 = " " " " " two prisms
t_3 = " " " " " three "
t_4 = " " " " " four "

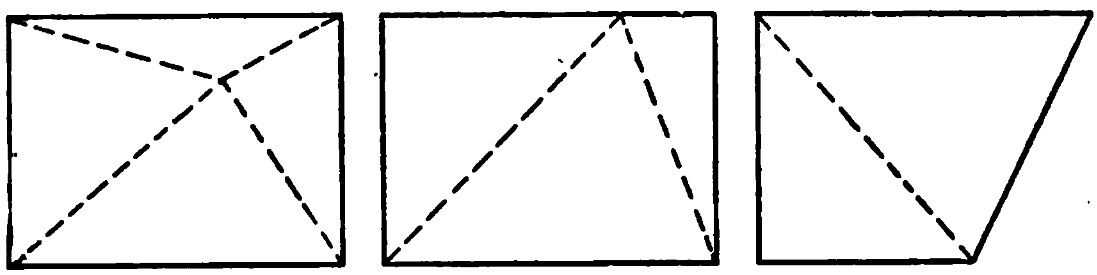
Then the total volume,

$$V_t = A\frac{t_1 + 2t_2 + 3t_3 + 4t_4}{4} \text{ (cu. ft.)} \tag{183}$$

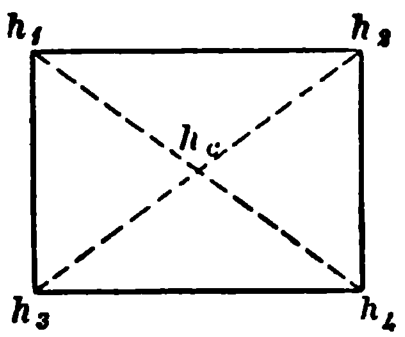
$$V_t = \frac{A}{27} \cdot \frac{t_1 + 2t_2 + 3t_3 + 4t_4}{4} \text{ (cu. yds.)} \tag{184}$$

253. Additional Heights.

When the surface of the ground is rough it is not unusual to take additional heights, the use of which, in general, involves appreciable labor in computation, it being necessary commonly to divide the solid into triangular prisms, as suggested by the figures just below, which include the case of a trapezoid.



The computations may be simplified in the two special cases which follow:



(*a*) When the additional height h_c is in the center of the rectangle.

Here the solid is composed of an assembly of 4 triangular prisms whose right sections are of equal area $= \frac{A}{4}$.

The volume of the assembled prisms

$$V = \frac{A}{4} \cdot \frac{2h_1 + 2h_2 + 2h_3 + 2h_4 + 4h_c}{3}$$

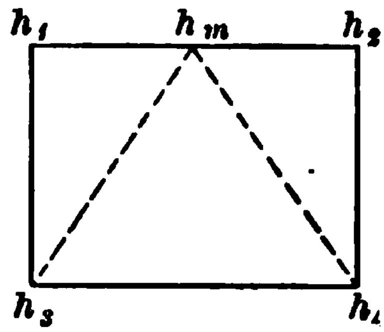
$$= \frac{A}{12}(2h_1 + 2h_2 + 2h_3 + 2h_4 + 4h_c)$$

$$= \frac{A}{12}(3h_1 + 3h_2 + 3h_3 + 3h_4) + \frac{A}{12}(4h_c - h_1 - h_2 - h_3 - h_4)$$

$$V = A\frac{h_1 + h_2 + h_3 + h_4}{4} + \frac{A}{3}\left(h_c - \frac{h_1 + h_2 + h_3 + h_4}{4}\right) \qquad (185)$$

or the total volume is that due to the four corner heights plus the volume of a pyramid of equal area of base and whose altitude is the difference between the center height and the mean of the four corner heights.

(*b*) When the additional height is at the middle of one side of the rectangle.



$$V = \frac{1}{3} \cdot \frac{A}{4}(h_1 + h_m + h_3 + h_2 + h_4 + h_m) +$$

$$\frac{1}{3} \cdot \frac{A}{2}(h_m + h_4 + h_3)$$

$$V = \frac{A}{12}(h_1 + h_m + h_3 + h_2 + h_4 + h_m + 2\,h_m + 2\,h_4 + 2\,h_3)$$

$$= \frac{A}{12}(h_1 + h_2 + 3\,h_3 + 3\,h_4 + 4\,h_m)$$

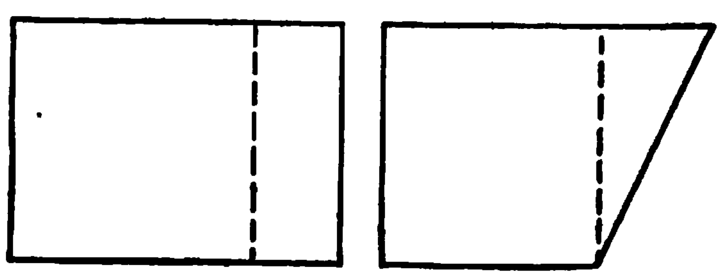
$$= \frac{A}{12}(3\,h_1 + 3\,h_2 + 3\,h_3 + 3\,h_4) + \frac{A}{12}(4\,h_m - 2\,h_1 - 2\,h_2)$$

$$= A\,\frac{h_1 + h_2 + h_3 + h_4}{4} + \frac{A}{3}\left(h_m - \frac{h_1 + h_2}{2}\right) \qquad (185\,A)$$

or the total solidity is that due to the four corner heights plus the solidity of a pyramid of equal area of base and whose altitude is the difference between the middle height and the mean of the adjacent side heights.

Apparently the principle of the pyramid applies conveniently only in these two cases.

For the case where the point lies on one of the sides, an alternate method of dividing the rectangle (or trapezoid) is indicated below.



The details of the computation in this case need not be worked out here.

254. The common practice in the case of borrow-pits is that stated in § 249. When the original surface and the surface to which the excavation is made are both somewhat rough and irregular, this method is naturally and properly adopted.

In many cases of excavation, the work is carried to a finished surface, sometimes a plane surface, or several planes, or some other very simple surface, sometimes to a more complicated surface where cross-sectioning the finished surface would not readily allow the facts to be shown on the plan.

In either of these cases the following method seems preferable.

(*a*) Cross-section the original surface as before.

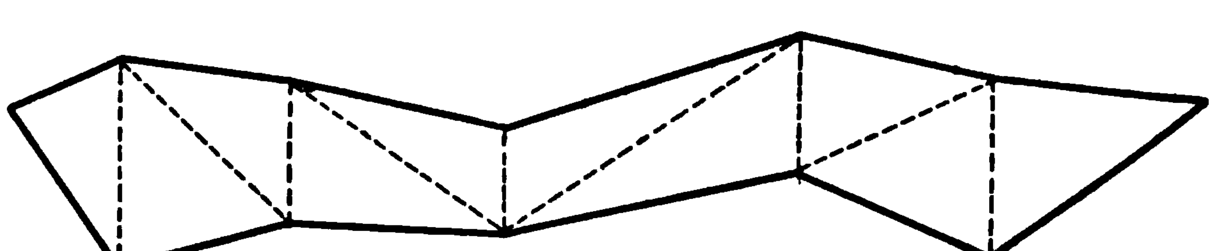
(*b*) Assume a convenient horizontal plane, slightly lower than the surface to which the excavation has been carried.

(*c*) Find the total earthwork to the original cross-sectioned surface, above this assumed plane as a base.

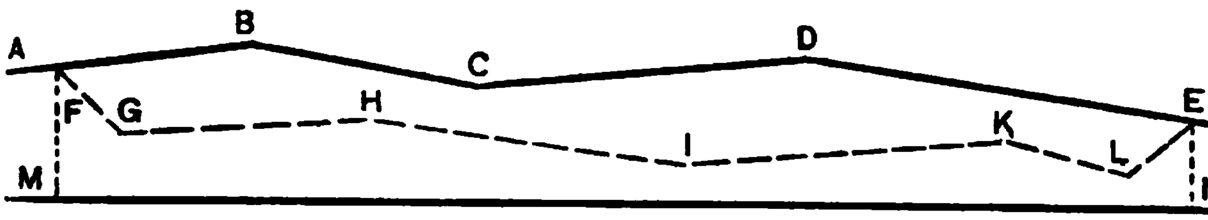
(*d*) Find the total earthwork to the finished surface, above the assumed plane as a base. In many cases this surface will be bounded by only a few planes and thus will allow very simple computations.

(*e*) Find the difference between (*c*) and (*d*); this will give the amount of earthwork excavated.

255. It often happens that an excavation is made of considerable length and not great breadth, and often of not great depth. In stripping soil under a proposed embankment these conditions prevail. The excavation can then best be handled very much as excavation is handled on railroads. A *line* will be run, and a series of cross-sections taken, the *line* serving as a center line, and cross-sections being taken at + stations along the line as often as required by the surface conditions. The cross-sections will be very irregular, not having any uniform base, but much as represented in the figure below.



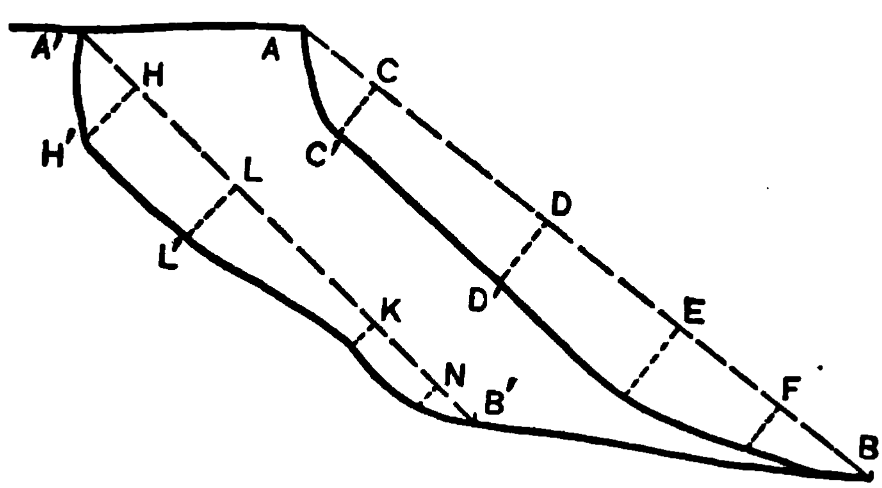
256. To find the area of these irregular sections, it may frequently happen that the best method may be one similar to that described for cross-sectioning on the preceding page.



(*a*) Find elevations on original surface ABCDE.
(*b*) Find elevations on excavated surface FGHIKLE.
(*c*) Assume a horizontal line at a convenient elevation MN.
(*d*) Calculate area MFBCDEN.
(*e*) Calculate area MFGHIKLEN.
(*f*) Area required is the difference between (*d*) and (*e*).

257. It is frequently necessary to find the excavation made by digging into the side of a high bank. Cross-section points on a steep slope, often in loose sand, cannot be expected to yield good results for computing excavation.

In such cases the following method may prove valuable.



(*a*) Determine with care both the position and elevation of point A at edge of top of bank; also of B near bottom of slope.

(*b*) Sight from A to bottom of stake at B and read on leveling rod CC', DD', etc., at the same time measuring AC, AD, etc.

(*c*) After the excavation has been made, find the positions of A' and B'; also the distances HH', LL', etc.; also A'H, A'L, etc.

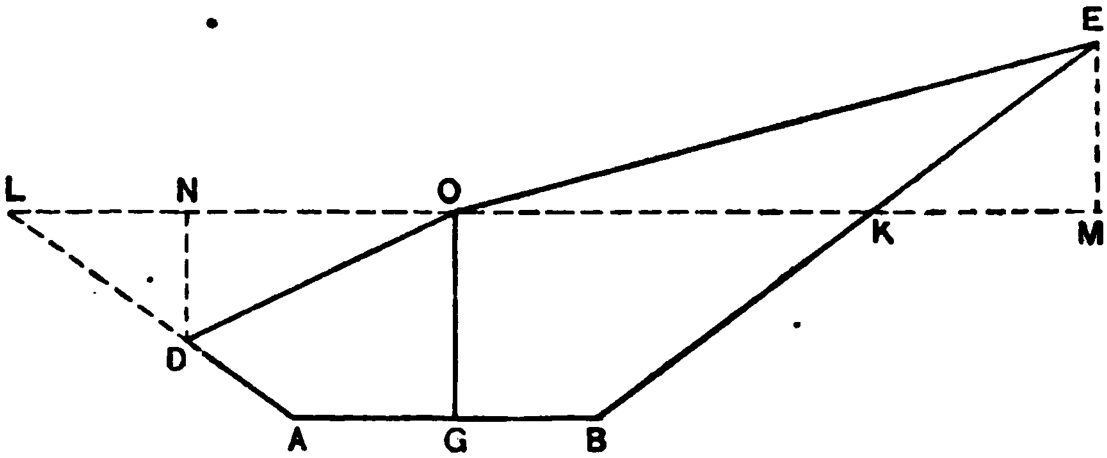
(*d*) Plot on cross-section paper and measure area between original surface and excavated surface. This can probably be done to best advantage by planimeter.

CHAPTER XIV.

EARTHWORK TABLES.

258. The calculation of quantities can be much facilitated by the use of suitably arranged "Earthwork Tables."

For regular "Three-Level Sections" very convenient tables can be calculated upon the following principles or formulas: —



Use notation as before for

$$c, \; h_l, \; h_r, \; d_l, \; d_r, \; s, \; l, \; A, \; S$$

Then
$$A = \text{ABKL} + \text{OKE} - \text{ODL}$$
$$= c(b + sc) + \frac{\text{OK} \times \text{EM}}{2} - \frac{\text{OL} \times \text{ND}}{2}$$
$$= c(b + sc) + \frac{\text{OK}}{2}(\text{EM} - \text{ND})$$
$$= c(b + sc) + \frac{1}{2}\left(\frac{b}{2} + sc\right)(h_r - c - c + h_l)$$
$$A = c(b + sc) + \frac{1}{2}\left(\frac{b}{2} + sc\right)(h_l + h_r - 2\,c)$$

For a prism of base A and $l = 50$, the solidity

$$S = 50\,A \text{ (cu. ft.)} = \frac{50}{27}\,A \text{ (cu. yds.)}$$

$$S = \frac{50}{27}c(b + sc) + \frac{25}{27}\left(\frac{b}{2} + sc\right)(h_l + h_r - 2\,c) \text{ (cu. yds.)} \qquad (186)$$

259. For cross-sections of a given base and slope, that is, given b and s constant, we may calculate for successive values of c, and tabulate values of L and K as follows: —

	L	K
c	$\frac{50}{27}c(b+sc)$	$\frac{25}{27}\left(\frac{b}{2}+sc\right)$

L represents the solidity for the *level section.*

K is for use as a correction. The formula then adapts itself to this table for any desired values of c, h_l, h_r.

$$S = L + K(h_l + h_r - 2c) \qquad (186\ \text{A})$$

Having found for successive stations S_0 and S_1 (each for a prism $l = 50$), then for the *full section* by "end areas,"

$$V_{e100} = S_0 + S_1$$

for

$$V_{e100} = \frac{A_0 + A_1}{2} \cdot \frac{100}{27} = \frac{50\,A_0}{27} + \frac{50\,A_1}{27}$$

$$V_{e100} = \qquad S_0 + S_1 \qquad (187)$$

260. When l is less than 100,

$$V_{el} = (S_0 + S_1)\,\frac{l}{100} \qquad (188)$$

For level sections $\qquad h_l = h_r = c$

$$h_l + h_r - 2c = 0$$

and the formula

$$S = L + K(h_l + h_r - 2c)$$

becomes $\qquad S = L \qquad (189)$

for level sections, and the quantities for any given values of c can be directly taken from column L without any correction from column K.

In preliminary estimates, or wherever center heights only are used, such tables are rapidly used.

261. Tables may be found in Allen's Tables XXXII for various bases for

$b = 20$	$s = 1\frac{1}{2}$ to 1	p. 252
$b = 14$	$s = 1\frac{1}{2}$ to 1	p. 248

An example will illustrate their use,

$$b = 14 \qquad s = 1\frac{1}{2} \text{ to } 1$$

Notes: —

Sta. 1	$\frac{16.0}{-6.0}$	-3.7	$\frac{12.4}{-3.6}$
0	$\frac{10.6}{-2.4}$	-2.5	$\frac{10.3}{-2.2}$

Calculations: —

$$\begin{array}{lrrr}
3.7 & L = 134.0 & K = 11.6 & h_l + h_r = 9.6 \\
 & + \underline{\ 25.5} & \underline{2.2} & 2c = \underline{7.4} \\
 & S_1 = 159.5 & 2.32 & +2.2 \\
 & & \underline{23.2} & \\
 & & 25.52 & \\
 & & & \\
2.5 & L = \ 82.2 & K = 10.0 & h_l + h_r = 4.6 \\
 & - \ \underline{4.0} & \underline{0.4} & 2c = \underline{5.0} \\
 & S_0 = \ 78.2 & 4.00 & -0.4
\end{array}$$

$$V_{100} = S_1 + S_0 = 237.7$$

262. There is also in Allen's Tables XXXI a "Table of Prismoidal Correction" calculated by the formula

$$C = \frac{1}{3.24}(c_0 - c_1)(D_0 - D_1)$$

In the example above

$$c_0 - c_1 = \ 2.5 - \ 3.7 = -1.2$$
$$D_0 - D_1 = 20.9 - 28.4 = -7.5$$

From Table find opp. 7.5 for 1   2.31

$$\begin{array}{rccr}
 & 2 & & \frac{4.63(10}{0.46} \\
V_{100} = V_e = 237.7 & 0.2 & \underline{0.46} & \\
C = \underline{\ \ 2.8} & & C = 2.77 & \\
V_p = 234.9 & & &
\end{array}$$

263. When the section is less than 100 ft. in length, the prismoidal correction is made before multiplying by $\frac{l}{100}$ that is,

$$V_{pl} = (S_0 + S_1 - C)\frac{l}{100} \tag{190}$$

264. Equivalent Level Sections.

The Table of p. 179 (or Table XXXII, Allen's Tables) shows in the L column the value of $S = \frac{50}{27}A$ for values of center height c. Conversely if there be given the S of any section, "irregular" or "regular three level," the value of c for a level section of the same area may be found from the L column.

Example. From p. 180, Base 14, Slope $1\frac{1}{2}$ to 1 for

$S_1 = 159.5$ $\quad$ $c = 4.2$ $\quad$ from Table XXXII

The notes of this section will be

$$\frac{13.3}{-4.2} \qquad -4.2 \qquad \frac{13.3}{-4.2}$$

265. For general calculations adapted both to regular "Three-Level Sections" and to "Irregular Sections," tables can be calculated upon the following principles and formulas: —

These tables are, in effect, tables of "Triangular Prisms," in which, having given (in feet) the base B and altitude a of any triangle, the tables give the solidity (in cubic yards) for a prism of length $l = 50$; that is,

$$S = \frac{aB}{2}\cdot\frac{50}{27} = \frac{50}{54}aB \tag{191}$$

Whenever the calculations can be brought into the form $S = \frac{50}{54}aB$, the result can be taken directly from the table.

266. In Allen's Field and Office Tables, "Three-Level Sections" are provided for in Table XXXII for slope of $1\frac{1}{2}$ to 1 and bases 14 to 30. "Prismoidal Corrections" are found in Table XXXI; and "Triangular Prisms" in Table XXX.

267. In the tables the formula $S = \frac{50}{54} aB$ takes form thus, $S = \frac{50}{54} \times$ *width* $\times$ *height*, and the tables are arranged as below.

	HEIGHTS.
WIDTHS	$\frac{50}{54}$ *width* $\times$ *height*

The application to "Three-Level Sections" is as follows:—
We have formula (162), p. 151,

$$A = \left(c + \frac{b}{2s}\right)\frac{D}{2} - \frac{b^2}{4s}$$

and for a prism 50 ft. in length ($l = 50$)

$$S = \frac{50}{27} A = \frac{50}{54}\left(c + \frac{b}{2s}\right) D - \frac{50}{54} \cdot \frac{b}{2s} \cdot b \qquad (192)$$

or S is the sum of two quantities, each of which is in proper form for the use of the tables.

For cross-sections of a given base and slope (b and s constants), $\frac{b}{2s}$ is a constant, and also $\frac{50}{54} \cdot \frac{b}{2s} \cdot b$ is constant.

We may then calculate once for all $\frac{b}{2s}$, and call this B (a constant).

Also $\frac{50}{54} \cdot \frac{b}{2s} \cdot b$, and call this a constant E.

Then
$$S = \frac{50}{54}(c + B)D - E$$

In using the tables, $c + B =$ height

$D =$ width

As in the previous tables, having found S_0 and S_1,

$$V_{100} = S_0 + S_1$$

and
$$V_l = (S_0 + S_1)\frac{l}{100}$$

268. Example. Allen's Tables XXX.

Notes :—

Sta. 1	$\dfrac{9.1}{-2.4}$	-1.2	$\dfrac{7.3}{-1.2}$
Sta. 0	$\dfrac{8.8}{-2.2}$	-0.7	$\dfrac{6.4}{-0.6}$

$b = 11$ $s = 1\frac{1}{2}$ to 1

$$\frac{b}{2s} = 3.7 = B$$

Grade triangle, $\dfrac{50}{54} \times 3.7 \times 11$

Under height 3.7, find

1 = 3.43		10.	= 34.3
1 = 3.43		1.	= 3.4
		E	= 37.7

Station 1. $c = 1.2$
$B = 3.7$
height $= 4.9$

$D = 9.1 + 7.3 = 16.4$

Under height 4.9, find

1 = 4.54	10.	= 45.4
6 = 27.22	6.	= 27.2
4 = 18.15	.4	= 1.8
		74.4
	E	= 37.7
	S_1	= 36.7

Station 0. $c = 0.7$
$B = 3.7$
height $= 4.4$

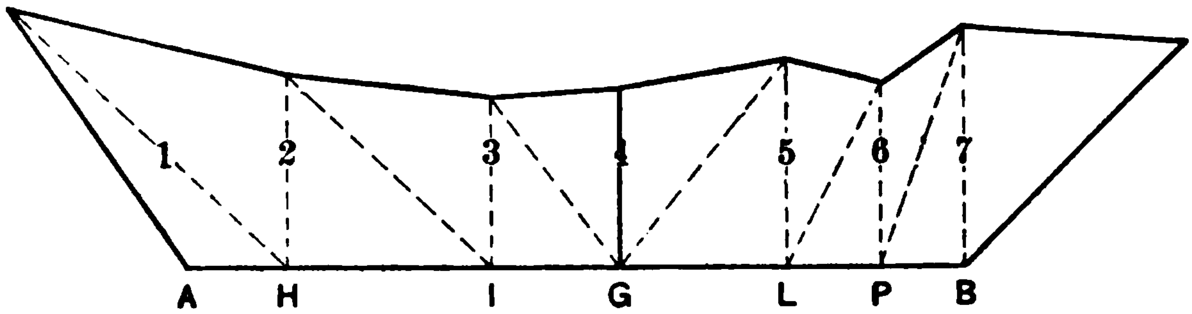
$D = 8.8 + 6.4 = 15.2$

Under height 4.4, find

1 = 4.07	10.	= 40.7
5 = 20.37	5.	= 20.4
2 = 8.15	.2	= 0.8
		61.9
	E	= 37.7
	S_0	= 24.2

$V = S_1 + S_0 = 60.9$

269. Irregular Sections.



An "Irregular Section" can be divided into triangular parts, as in the figure. Taking generally two triangular parts together for purposes of calculation, we have

$$A_1 = \frac{h_l \times (\mathrm{AG} - d_{\mathrm{H}})}{2} \qquad s_1 = \frac{50}{54} h_l(\mathrm{AG} - d_{\mathrm{H}})$$

$$A_2 = \frac{h_{\mathrm{H}} \times (d_l - d_{\mathrm{I}})}{2} \qquad s_2 = \frac{50}{54} h_{\mathrm{H}}(d_l - d_{\mathrm{I}})$$

$$A_3 = \frac{h_{\mathrm{I}} \times (d_{\mathrm{H}} - 0)}{2} \qquad s_3 = \frac{50}{54} h_{\mathrm{I}} d_{\mathrm{H}}$$

$$A_4 = \frac{c \times (d_{\mathrm{I}} + d_{\mathrm{L}})}{2} \qquad s_4 = \frac{50}{54} c(d_{\mathrm{I}} + d_{\mathrm{L}})$$

$$A_5 = \frac{h_{\mathrm{L}} \times (d_{\mathrm{P}} - 0)}{2} \qquad s_5 = \frac{50}{54} h_{\mathrm{L}} d_{\mathrm{P}}$$

$$A_6 = \frac{h_{\mathrm{P}} \times (d_{\mathrm{B}} - d_{\mathrm{L}})}{2} \qquad s_6 = \frac{50}{54} h_{\mathrm{P}}(d_{\mathrm{B}} - d_{\mathrm{L}})$$

$$A_7 = \frac{h_{\mathrm{B}} \times (d_r - d_{\mathrm{P}})}{2} \qquad s_7 = \frac{50}{54} h_{\mathrm{B}}(d_r - d_{\mathrm{P}})$$

$$S = s_1 + s_2 + s_3 + s_4 + s_5 + s_6 + s_7 \qquad (193)$$

$$V_{100} = S_0 + S_1$$

$$V_l = (S_0 + S_1)\frac{l}{100}$$

The calculation of Irregular Sections in rough country becomes very laborious unless the best methods are used, and this process should be thoroughly understood.

CHAPTER XV.

EARTHWORK DIAGRAMS.

270. Computations of earthwork may also be made by means of diagrams from which results may be read by inspection merely.

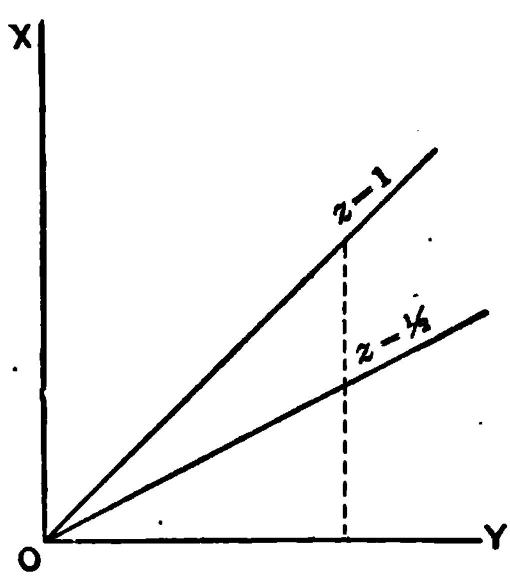
The principle of their construction is explained as follows:—

Given an equation containing three variable quantities as

$$x = zy \qquad (194)$$

If we assume some value of z (making z a constant), the equation then becomes the equation of a right line.

If this line be platted, using rectangular coördinates (as the line $z = 1$ in the figure), then having given any value of y, the corresponding value of x may be taken off by scale. If a new value of z be assumed, the equation is obtained of a new line which may also be platted (as $z = \frac{1}{2}$ in the figure), and from which also, having given any value of y, the corresponding value of x may be determined by scale. Assuming a series of values of z and platting, we have a series of lines, each representing a different value of z,

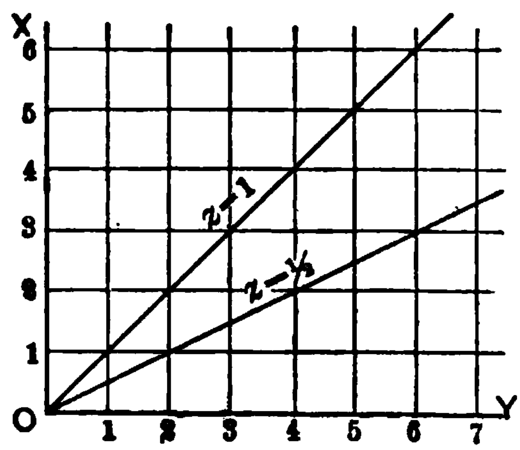


and from any one of which, having given a value of y, we may by scale determine the value of x.

Thus, *given*, values of z and y; *required*, x, we may find,

1. The line corresponding to the given value of z, and
2. Upon this line we may find the value of x corresponding to the given value of y.

271. Next, if instead of platting upon *lines* as coördinate axes, we plat upon cross-section paper, the cross-section lines form a scale, so that the values of x and y need not be *scaled*, but may be *read* by simple inspection as in the figure.



272. If the equation be in the form

$$x = azy \tag{195}$$

the same procedure is equally possible, and the line representing any value of z will still be a right line.

If the equation be in the form

$$x = a(z + b)(y + c) + d \tag{196}$$

in which a, b, c, d, are constants, the same procedure is still possible, and the line representing a given value of z is a right line, as before.

The use of diagrams of this sort is therefore possible for the solution of equations in the form of

$$x = a(z + b)(y + c) + d$$

or in simpler modifications of this form.

273. Referring again to the figure above, we may consider the horizontal lines to represent successive values of x and refer to them as the lines

$$x = 0\,;\; x = 1\,;\; x = 2, \text{ etc.}$$

and similarly we may refer to vertical lines as the lines

$$y = 0\,;\; y = 1\,;\; y = 2, \text{ etc.}$$

just as we refer to the inclined lines

$$z = \tfrac{1}{2}\,;\; z = 1, \text{ etc.}$$

Having given any two of the quantities x, y, z, the third may be found by inspection from the diagram by a process similar to that described.

274. Diagram for Prismoidal Correction.

Formula $$C = \frac{1}{3.24}(c_0 - c_1)(D_0 - D_1) \qquad (168)$$

This has the form $x = \ a \times \ z \times \ y$

Construction of diagram.

Assume (as we did for z) a series of values of

$$c_0 - c_1 = 0,\ 1,\ 2,\ 3,\ 4,\ 5, \text{ etc.}$$

When $c_0 - c_1 = 0$ then $C = 0$
or, the line $c_0 - c_1$ coincides with the line $C = 0$.

When $c_0 - c_1 = 1$, the equation of the line $c_0 - c_1$ is

$$C = \frac{1}{3.24}(D_0 - D_1)$$

To piat this right line, we must find two or more points on the line. For the reason that cross-section paper is generally warped somewhat, it is best to take a number of points not more than 3 or 4 inches apart, in order to get the lines sufficiently exact. For convenience, take values of $D_0 - D_1$ as follows: —

When $(c_0 - c_1) = 1$

take $D_0 - D_1 = 0$, 3.24, 6.48, 9.72, 12.96, 16.20, etc.

then $C = 0$, 1 , 2 , 3 , 4 , 5 , etc.

When $c_0 - c_1 = 2$, the equation of the line $c_0 - c_1$ is

$$C = \frac{1}{3.24} \cdot 2(D_0 - D_1)$$

Therefore when $c_0 - c_1 = 2$

take $D_0 - D_1 = 0$, 3.24, 6.48, 9.72, 12.96, 16.20, etc.

then $C = 0$, 2 , 4 , 6 , 8 , 10 , etc.

275. In like manner a table may be constructed.

	0	3.24	6.48	9.72	12.96	16.20	19.44	22.68	25.92	D_0-D_1
0	0	0	0	0	0	0	0	0	0	
1	0	1	2	3	4	5	6	7	8	
2	0	2	4	6	8	10	12	14	16	
3	0	3	6	9	12	15	18	21	24	
4	0	4	8	12	16	20	24	28	32	
5	0	5	10	15	20	25	30	35	40	
6	0	6	12	18	24	30	36	42	48	
7	0	7	14	21	28	35	42	49	56	
8	0	8	16	24	32	40	48	56	64	
9	0	9	18	27	36	45	54	63	72	
10	0	10	20	30	40	50	60	70	80	
c_0-c_1										

276. It will be noticed that when $D_0 - D_1 = 0$, $C = 0$. Therefore for all values of $c_0 - c_1$, the lines pass through the origin.

We may proceed to plat the lines $c_0 - c_1 = 1$, $c_0 - c_1 = 2$, $c_0 - c_1 = 3$, etc., from data shown in the above table, platting upon the lines $D_0 - D_1 = 3.24$, $D_0 - D_1 = 6.48$, etc., the points shown with circles around them in the cross-section sheet, p. 189.

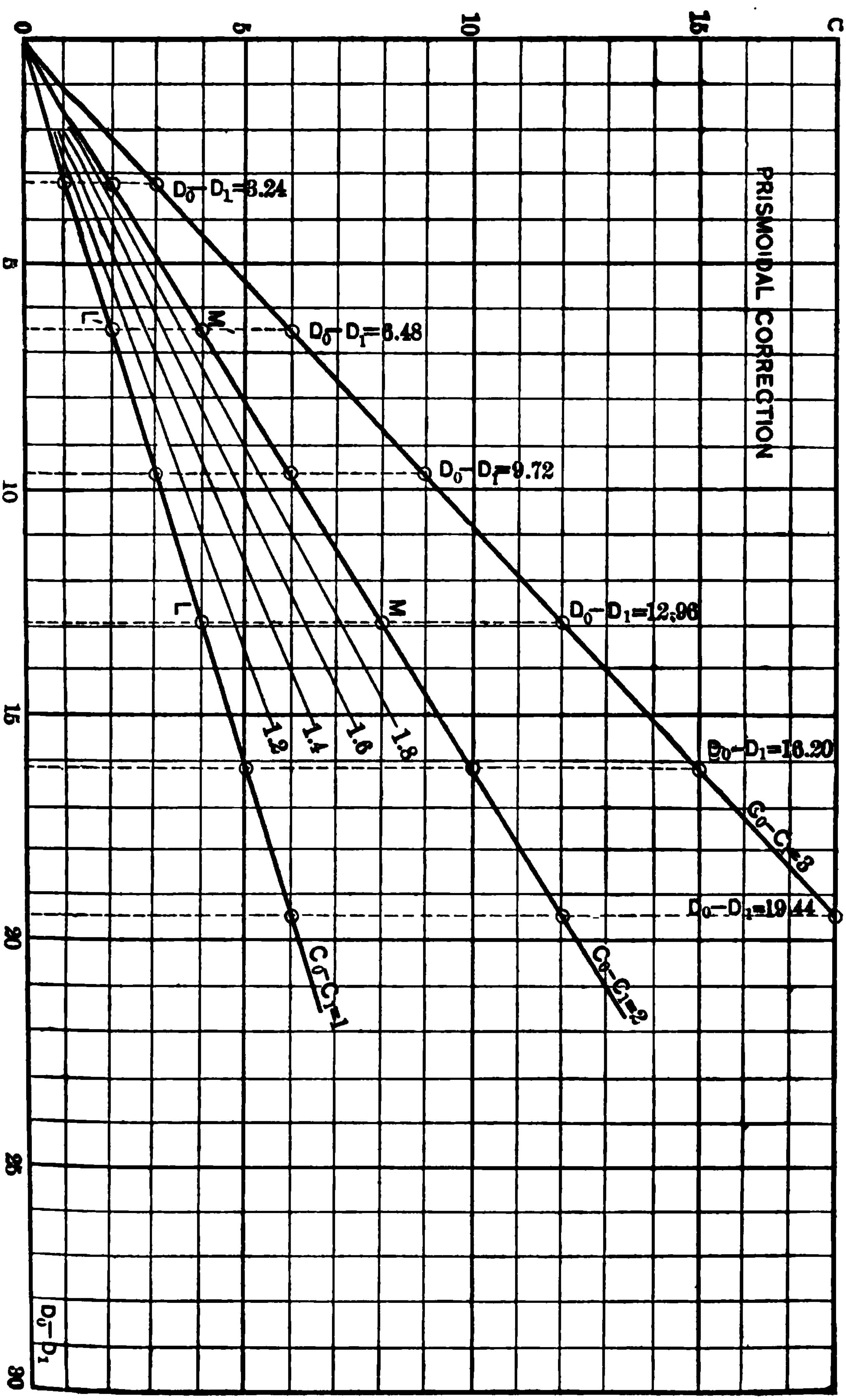
Having the lines $c_0 - c_1 = 1$, $c_0 - c_1 = 2$, 3, platted, intermediate lines are interpolated mechanically upon the principle that *vertical* lines would be proportionally divided (as ML is proportionally divided into 5 equal parts), and points are marked for the lines

$$c_0 - c_1 = 1.2, \qquad 1.4, \qquad 1.6, \qquad 1.8$$

For the most convenient use, the values of $c_0 - c_1$ are taken to every second tenth of a foot in interpolating, as is shown on the diagram, p. 189, between 1 and 2; that is,

1.2, 1.4, 1.6, 1.8

A complete diagram is shown at the back of the book.


PRISMOIDAL CORRECTION
0
5
10
15
C
5
10
15
20
25
30
D0−D1=3.24
D0−D1=6.48
D0−D1=9.72
D0−D1=12.96
D0−D1=16.20
D0−D1=19.44
L′
M′
L
M
1.2
1.4
1.6
1.8
C0−C1=1
C0−C1=2
C0−C1=3
D0−D1

277. For Use.

Find the diagonal line corresponding to the given value of $c_0 - c_1$; follow this up until the vertical line representing the given value of $D_0 - D_1$ is reached, and the intersection is thus found. Then read off the value of C corresponding to this intersection.

Example. $c_0 - c_1 = 1.2$, $D_0 - D_1 = 11.0$ $\qquad C = 4.0$

again, $c_0 - c_1 = 1.7$, $D_0 - D_1 = 7.0$ $\qquad C = 3.6 \pm$

278. Diagram for Triangular Prisms.

From formula (191), $S = \frac{50}{54} cD$, a table may be constructed.

	0	5.4	10.8	16.2	21.6	27.0	*D*
0	0	0	0	0	0	0	
1	0	5	10	15	20	25	
2	0	10	20	30	40	50	
3	0	15	30	45	60	75	
4	0	20	40	60	80	100	
5	0	25	50	75	100	125	
6	0	30	60	90	120	150	
7	0	35	70	105	140	175	
8	0	40	80	120	160	200	
9	0	45	90	135	180	225	
10	0	50	100	150	200	250	
c							

From this a diagram can be constructed similar in form to that for Prismoidal Correction.

The lines for all values of c pass through the origin.

In constructing this table, any values of D might have been taken instead of those used here. Those used were selected because they give results simple in value, easily obtained, and readily platted.

279. Diagram for Three-Level Sections.

Formula, $$S = \frac{50}{54}\left(c + \frac{b}{2s}\right)D - \frac{50}{54} \cdot \frac{b}{2s} \cdot b \tag{192}$$

A separate diagram will be required for each value (or combination of values) of b and s. Since b and s thus become constants, the formula assumes the form of

$$x = a(z + b)y + d \tag{197}$$

and the diagram will consist of a series of right lines.

A table can be made up by taking successive values of $c = 0$, 1, 2, 3, 4, etc., and finding for each of these the value of S corresponding to different values of D, using the above formula.

To make separate and complete computations directly by formula would be quite laborious; there is, however, a method of systematizing the construction of the *table* which can be shown better by example than in any other way.

280. *Example.* $b = 14$ $\qquad s = 1\frac{1}{2}$ to 1

Formula $$S = \frac{50}{54}\left(c + \frac{b}{2s}\right)D - \frac{50}{54} \cdot \frac{b}{2s} \cdot b$$

becomes $$S = \frac{50}{54}\left(c + \frac{14}{3}\right)D - \frac{50}{54} \cdot \frac{14}{3} \cdot 14$$

$$S = \frac{50}{54}\left(c + \frac{14}{3}\right)D - 60.49 \tag{198}$$

A table has been prepared for successive values of

$$c = 0, \quad 1, \quad 2, \quad 3, \quad 4, \quad 5, \quad \text{etc.}$$

and for $\quad D = 14, \quad 16.2, \quad 21.6, \quad 27.0, \quad$ etc.

These values of D are selected for the following reasons: $D = 14$ is the least possible value; $D = 16.2$, 21.6 are desirable because they are multiples of 5.4, and the factors in the formula show that the computations will be simplified by selecting multiples of 5.4 for the successive values of D.

	14	16.2	21.6	27.0	32.4	37.8	43.2	*D*
	12.963	15.	20.	25.	30.	35.	40.	Const. diff.
0	0	9.51	32.84	56.18	79.51	102.84	126.18	
1	12.963	24.51	52.84	81.18	109.51	137.84	166.18	
2	25.926	39.51	72.84	106.18	139.51	172.84	206.18	
3	38.889	54.51	92.84	131.18	169.51	207.84	246.18	
4	51.852	69.51	112.84	156.18	199.51	242.84	286.18	
5	64.815	84.51	132.84	181.18	229.51	277.84	326.18	
6	77.778	99.51	152.84	206.18	259.51	312.84	366.18	
7	90.741	114.51	172.84	231.18	289.51	347.84	406.18	
8	103.704	129.51	192.84	256.18	319.51	382.84	446.18	
9	116.667	144.51	212.84	281.18	349.51	417.84	486.18	
10	129.630	159.51	232.84	306.18	379.51	452.84	526.18	
c								

When $c = 0$ $\quad S = \frac{50}{54} \cdot \frac{14}{3} \cdot D - 60.49$

When $D = 14$ $\quad S = \frac{50}{54} \cdot \frac{14}{3} \cdot 14 - 60.49$

$$= 60.49 - 60.49 = 0$$

When $D = 16.2$

we may again calculate directly

$$S = \frac{50}{54} \cdot \frac{14}{3} \cdot 16.2 - 60.49$$

but a better method is to find how much greater S will be for $D = 16.2$ than for $D = 14.0$.

We have $\quad S = \frac{50}{54} \cdot \frac{14}{3} \cdot D - 60.49$

Then for any new value D'

$$S' = \frac{50}{54} \cdot \frac{14}{3} \cdot D' - 60.49$$

$$S' - S = \frac{50}{54} \cdot \frac{14}{3}(D' - D) \tag{199}$$

for $\quad D' = 16.2 \quad D = 14.0 \quad D' - D = 2.2$

$$S' - S = \frac{50}{54} \cdot \frac{14}{3} \times 2.2 = 9.51$$

$$S = 0$$

$S' = 9.51$, which is entered in table.

Similarly, $S'' - S' = \frac{50}{54}\cdot\frac{14}{3}(D'' - D')$

$$D'' = 21.6 \qquad D' = 16.2 \qquad D'' - D' = 5.4$$

$$S'' - S' = \tfrac{50}{54}\times\tfrac{14}{3}\times 5.4$$

$$= 23.333$$

$$\begin{array}{rrcrr}
S' = & 9.51 & & S^{\text{iv}} = & 79.509 \\
\hline
S'' = & 32.843 & & & 23.333 \\
\cline{5-5}
S''' - S'' = & 23.333 & & S^{\text{v}} = & 102.842 \\
\hline
S''' = & 56.176 & & & 23.333 \\
\cline{5-5}
S^{\text{iv}} - S''' = & 23.333 & & S^{\text{vi}} = & 126.175 \\
\hline
S^{\text{iv}} = & 79.509 & & &
\end{array}$$

(The second "Similarly," stands beside the line $S''' - S'' = 23.333$.)

Constant increment for $D' - D = 5.4$ is 23.333.

281. Each result is entered in the table in its proper place. The final result for $c = 0$ and $D = 43.2$ should be calculated independently as a check.

When $c = 0$ $\qquad S = \frac{50}{54}\cdot\frac{14}{3}\cdot D - 60.49$

When $D = 43.2$ $\qquad S = \frac{50}{54}\cdot\frac{14}{3}\times 43.2 - 60.49$

$$= 50\times\tfrac{14}{3}\times 0.8 - 60.49$$

$$= \tfrac{560}{3} - 60.49$$

$$= 186.67 - 60.49$$

$$S = 126.18$$

This checks exactly, and all intermediate values are checked by this process, which is also more rapid than an independent calculation for each value of D.

282. We now have values of S for the various values of $D = 14.0$, 16.2, 21.6, etc., when $c = 0$.

Next, find how much these will be increased when $c = 1$.

Formula $\qquad S = \frac{50}{54}(c + \frac{14}{3})D - 60.49$

for any new value c' $\qquad S' = \frac{50}{54}(c' + \frac{14}{3})D - 60.49$

$$S' - S = \tfrac{50}{54}(c' - c)D \qquad (200)$$

When $\quad c' = 1$ and $c = 0, \qquad c' - c = 1$

$$S' - S = \tfrac{50}{54} D$$

Similarly, $\quad S'' - S' = \tfrac{50}{54}(c'' - c')D$

When $\quad c'' = 2$ and $c' = 1, \qquad c'' - c' = 1$

$$S'' - S' = \tfrac{50}{54} D$$

That is, for *any increase* of 1 ft. in the value of c,

$$S' - S = \tfrac{50}{54} D \tag{201}$$

When $\qquad D = 14$

$$S' - S = \tfrac{50}{54} \times 14 = 12.963$$

This we enter as the constant difference for column $D = 14$.

We have already found

$$\begin{aligned} S_0 &= 0 \\ &\ \underline{12.963} \\ S_1 &= 12.963 \\ &\ \underline{12.963} \\ S_2 &= 25.926 \end{aligned}$$

This gives column 14. $\qquad S_3 = 38.889$ etc.

When $\qquad D = 16.2$

(201) $\qquad S' - S = \tfrac{50}{54} D = \tfrac{50}{54} \times 16.2 = 50 \times 0.3$

$$= 15$$

Enter 15 as the constant difference in column 16.2.

We already have

$$\begin{aligned} S_0 &= 9.51 \\ &\ \underline{15.} \\ S_1 &= 24.51 \\ &\ \underline{15.} \\ S_2 &= 39.51 \end{aligned}$$

This allows us to complete column 16.2. $\quad S_3 = 54.51$ etc.

Similarly for $\quad D = 21.6 \qquad S' - S = 20$

Enter 20 as constant difference in column 21.6, and complete column as shown in table.

Similarly, fill out all the columns shown in the table.

283. The final result for $c = 10$, $D = 43.2$ should be calculated independently, and directly from the formula, as a check.

$$S = \tfrac{50}{54}(c + \tfrac{14}{3})D \qquad - 60.49$$

$$c = 10 \qquad D = 43.2$$

$$S = \tfrac{50}{54} \times 14.667 \times 43.2 - 60.49$$

$$= 50 \times 14.667 \times \ \ 0.8 - 60.49$$

$$= 40 \times 14.667 \qquad - 60.49$$

$$= 586.68 \qquad - 60.49$$

$$S = 526.19$$

The table gives 526.18. This checks sufficiently close to indicate that no error has been made. It would yield an exact check if we took $c + \frac{14}{3} = 14.6667$.

284. Note that for	$c = 10$	$D = 43.2$	value	$= 526.18$
	$c = 10$	$D = 37.8$	"	452.84
			Diff.	$= 73.34$
Between	$c = 10$	$D = 37.8$	Diff.	$= 73.33$
and	$c = 10$	$D = 32.4$		

In line $c = 10$ a constant difference is found between successive values of D differing by 5.4. This may be demonstrated to be $= 73.33$.

All values in the table except column 14 are satisfactorily checked by applying this difference of 73.33 in line 10 together with the independent check of $c = 10$, $D = 43.2$.

The value of $c = 10$, $D = 14$ can also be checked and shown to be correct.

285. Having the table, page 192, completed, the construction of the diagram is simple.

The "*Diagram for Three-Level Sections, Base* 14, *Slope* 1½ *to* 1," was calculated and constructed according to this table. The Diagram given shows a general arrangement of lines and figures convenient for use. For rapid and convenient use, the diagram should be constructed upon cross-section paper, Plate G; and in this case the diagram will be upon a scale twice that of the diagram accompanying these notes.

A "curve of level section" has been platted on this diagram in the following manner. For level sections, when

$c = 0$	$D = 14.0$	$c = 2$	$D = 20.0$
$c = 1$	$D = 17.0$	$c = 6$	$D = 32.0$
$c = 1.4$	$D = 18.2$ etc.		

The line passing through these points gives the "curve of level section."

Aside from the direct use of this curve of level section (for preliminary estimates or otherwise), it is very useful in tending to prevent any gross errors in the use of the table, since, in general, the points (intersections) used in the diagram will lie not far from the curve of level section.

286. Use of Diagram.

Find the diagonal line corresponding to the given value of c; follow this up until the vertical line representing the given value of D is reached, and this intersection found. Then read off the value of S corresponding to this intersection.

Example. Notes.

Sta. 1	$\dfrac{16.0}{-6.0}$	-3.7	$\dfrac{12.4}{-3.6}$	$S_1 = 160.$
Sta. 0	$\dfrac{10.6}{-2.4}$	-2.5	$\dfrac{10.3}{-2.2}$	$S_0 = \underline{\ 78.}$
				$V = 238.$

For Sta. 1 $c = 3.7$ $D = 25.4$

$c = 3.7$ is the middle of the space between 3.6 and 3.8.

Follow this up until the vertical line 28.4 is reached.

The intersection lies upon the line $S_1 = 160$.

Enter this above opposite Sta. 1.

For Sta. 0 $c = 2.5$ $D = 20.9$

$c = 2.5$ is the middle of space between 2.4 and 2.6.

Follow this up until the middle of space between 20.8 and 21.0 is reached.

The intersection lies just above the line

$$S_0 = 78$$

Enter this opposite Sta. 0.

$$V_{100} = S_1 + S_0$$
$$= 160 + 78 = 238 \text{ cu. yds.}$$

The prismoidal correction may be applied if desired.

287. Diagrams may be constructed in this way that will give results to a greater degree of precision than is warranted by the precision reached in taking the measurements on the ground.

In point of rapidity *diagrams are much more rapid than tables* for the computation of *Three-Level Sections.*

For "*Triangular Prisms*" and for *Prismoidal Correction*, the *diagrams* are *somewhat more rapid.*

For *Level Sections*, the tables for Three-Level Sections are *at least equally rapid.*

288. The use of approximate methods for applying the prismoidal correction to irregular sections will now be rendered very practicable by the use of these "Diagrams for Three-Level Sections."

Method 1. No use of diagrams is necessary.

Method 2. Having found for any irregular sections (by triangular prisms or any other method) the solidity S for 50 ft. in length, find upon the diagram the line corresponding to this value of S; follow this line to the curve of level section, and read off the value of c (for a level section) which corresponds, and also the value of D for the same section.

Method 3. Having found in any way the value of S; if c is given, find the value of D to correspond; if D is given, find the value of c to correspond.

Method 4. The use of diagrams is not needed.

The diagrams shown at the back of the book are given partly to show a good scheme or arrangement, and partly to allow practice in their use. For regular work the scale is too small to be desirable, and trying to the eyes. They are not sufficiently extensive. In offices where there is much earthwork computation to be done, diagrams should be constructed on double the scale and extending to higher numbers. Several sheets may be required for each kind of diagram. It may seem that sufficiently precise values cannot be read from these diagrams, but the diagrams are much more precise than the field-work, where a center cut is not sure to one tenth of a foot.

CHAPTER XVI.

HAUL.

289. When material from excavation is hauled to be placed in embankment, it is customary to pay to the contractor a certain sum for every cubic yard hauled. Oftentimes it is provided that no payment shall be made for material hauled less than a specified distance. In the east a common limit of "free haul" is 1000 ft. Often in the west 500 ft. is the limit of "free haul." Sometimes 100 ft. is the limit.

A common custom is to make the unit for payment of haul, one yard hauled 100 ft.; the price paid will often be from 1 to 2 cents per cubic yard hauled 100 ft.

The price paid for "haul" is small, and therefore the standard of precision in calculation need not be quite as fine as in the calculation of the quantities of earthwork. The total "haul" will be the product of

(1) the total amount of excavation hauled, and

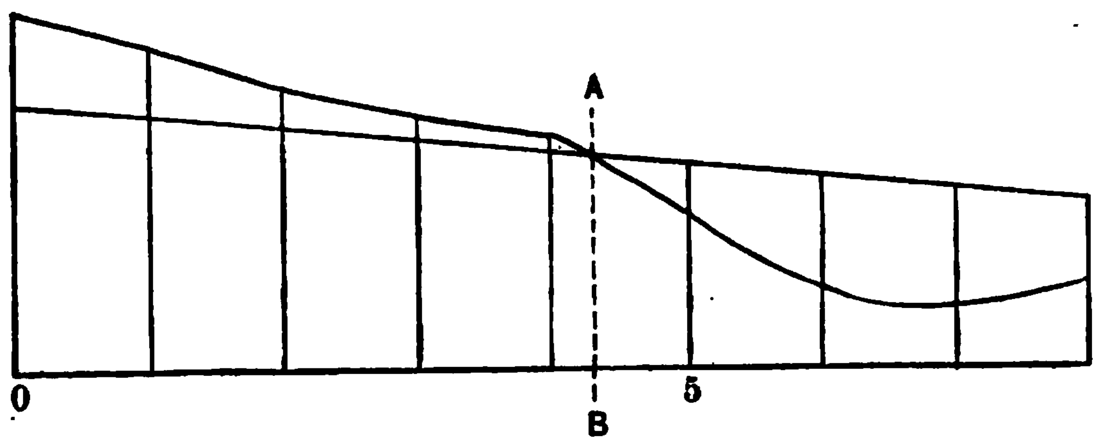
(2) the average length of haul.

290. The average length of haul is the distance between the center of gravity of the material as found in excavation, and the center of gravity as deposited. It would not, in general, be simple to find the center of gravity of the entire mass of excavation hauled, and the most convenient way is to take each section of earthwork by itself. The "haul" for each section is the product of the

(1) number of cubic yards in that section, and

(2) distance between the center of gravity in excavation, and the center of gravity as deposited.

291. When excavation is placed in embankment, there may be some difficulty in determining just where any given section of excavation will be placed, and where its center of gravity will be in embankment.



In hauling excavation in embankment, there is some plane, as indicated by AB, *to* which all excavation must be hauled on its way to be placed in embankment, and (another way of putting it) *from* which all material placed in embankment must be hauled on its way from excavation. We may figure the total haul as the sum of

(1) total "haul" of excavation *to* AB, and

(2) total "haul" of embankment *from* AB.

The total "haul" of excavation *to* AB and the total "haul" of embankment *from* AB will most conveniently be calculated as the sum of the hauls of the several sections of earthwork. For each section the haul is the product of

(1) the volume V of that section, and

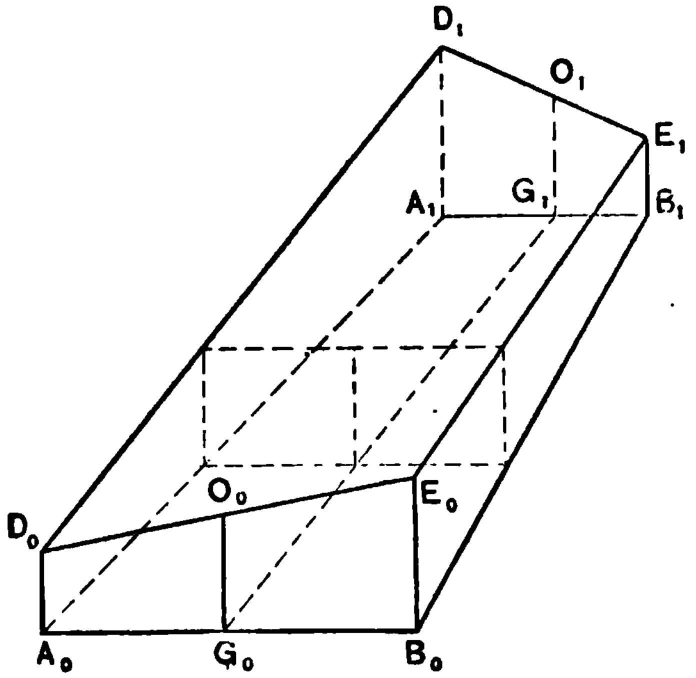
(2) distance from center of gravity of that section to the plane AB.

292. When the two end areas are equal, the center of gravity will be midway between the two end planes. When the two end areas are not equal in value, the center of gravity of the section will be at a certain distance from the mid-section, as shown by the formula

$$x_g = \frac{l^2}{12} \cdot \frac{A_1 - A_0}{V}$$

in which x_g = distance of center of gravity from mid-section.

293. Referring to the figure below, and following the same general method of demonstration used previously, § 235,



let $b_0 =$ base $= A_0B_0$

$b_1 =$ " $= A_1B_1$

$c_0 =$ center ht. $= O_0G_0$

$c_1 =$ center ht. $= O_1G_1$

$l =$ length (altitude) of section $= G_0G_1$

$A_0 =$ area of $D_0A_0B_0E_0$

$A_1 =$ area of $D_1A_1B_1E_1$

$V =$ volume

Also use notation b_x, c_x, A_x for a section distant x from G_1.

Find the distance of the center of gravity from $A_1B_1E_1D_1$, and let this $= x_c$. Let $x_g =$ distance of center of gravity from mid-section.

Then for any elementary section of thickness dx and distance x from $A_1B_1E_1D_1$, its moment will be

$$\left[b_1 + (b_0 - b_1)\frac{x}{l}\right]\left[c_1 + (c_0 - c_1)\frac{x}{l}\right] x\,dx$$

$$V \cdot x_c = \int_0^l \left[b_1 + (b_0 - b_1)\frac{x}{l}\right]\left[c_1 + (c_0 - c_1)\frac{x}{l}\right] x\,dx$$

$$V \cdot x_c = \frac{b_1c_1l^2}{2} + \frac{b_1(c_0-c_1)l^3}{3\,l} + \frac{c_1(b_0-b_1)l^3}{3\,l} + \frac{(c_0-c_1)(b_0-b_1)l^4}{4\,l^2}$$

$$= \frac{l^2}{12}\left[\begin{array}{l} 6\,b_1c_1 + 4\,b_1c_0 + 4\,b_0c_1 + 3\,b_0c_0 \\ -\,4\,b_1c_1 - 3\,b_1c_0 - 3\,b_0c_1 \\ -\,4\,b_1c_1 \\ +\,3\,b_1c_1 \end{array}\right]$$

$$V \cdot x_c = \frac{l^2}{12} \times (b_1c_1 + b_1c_0 + b_0c_1 + 3\,b_0c_0)$$

$$x_c = \frac{l^2}{12} \times \frac{b_1c_1 + b_1c_0 + b_0c_1 + 3\,b_0c_0}{V} \qquad (202)$$

What is wanted is x_g rather than x_c.

$$x_g = \frac{l}{2} - x_c$$

$$Vx_g = V\frac{l}{2} - Vx_c$$

$$V = \frac{l}{6}(2\,b_1c_1 + 2\,b_0c_0 + b_1c_0 + b_0c_1) \qquad \text{from (164)}$$

$$V \cdot \frac{l}{2} = \frac{l^2}{12}(2\,b_1c_1 + 2\,b_0c_0 + b_1c_0 + b_0c_1) \tag{203}$$

$$V \cdot x_c = \frac{l^2}{12}\;(b_1c_1 + 3\,b_0c_0 + b_1c_0 + b_0c_1)$$

$$V \cdot x_g = \frac{l^2}{12}\;(b_1c_1 - \;\; b_0c_0)$$

$$= \frac{l^2}{12}\;(A_1 - A_0)$$

$$x_g = \frac{l^2}{12}\;\frac{A_1 - A_0}{V} \quad (V \text{ in cu. ft.}) \tag{204}$$

$$x_g = \frac{l^2}{12 \times 27} \cdot \frac{A_1 - A_0}{V} \quad (V \text{ in cu. yds.}) \tag{205}$$

294. The formula above applies to the solid shown in the figure, which has trapezoidal ends, but it will apply also when D_0A_0, D_1A_1 are each $= 0$, and therefore applies to such solids having triangular ends; and since any section of earthwork with parallel ends may be divided into a number of such solids with triangular ends, it applies to all ordinary sections of railroad earthwork, since it applies to the parts of which it is made up.

To show that in fact this formula is correct for prisms, wedges, and pyramids, use a method similar to that shown on page 155; find for each solid an expression for x_g in terms of A and l; reduce to the form

$$x_g = \frac{l^2}{12} \cdot \frac{A_1 - A_0}{V}$$

295. The formula

$$x_g = \frac{l^2}{12 \times 27} \cdot \frac{A_1 - A_0}{V}$$

is not in form convenient for use, because we have not found the values of A_1 and A_0, but instead have calculated directly from the tables or diagrams the values of S_1 and S_0 for 50 ft. in length, where

$$S_1 = \frac{50}{27} A_1, \text{ or } A_1 = \frac{27\ S_1}{50}$$

and

$$A_0 = \frac{27}{50} S_0$$

Substituting, $$x_{g_{100}} = \frac{100 \times 100}{12 \times 27} \cdot \frac{S_1 - S_0}{V} \cdot \frac{27}{50}$$

$$x_{g_{100}} = \frac{100}{6} \cdot \frac{S_1 - S_0}{V} \tag{206}$$

where V is the correct volume in cu. yds.

This formula is in shape convenient for use, and results correct to the nearest foot can be calculated with rapidity.

296. For a section of length l less than 100 ft.

$$x_{g_l} = \frac{l^2}{12 \times 27} \cdot \frac{A_1 - A_0}{V_l}$$

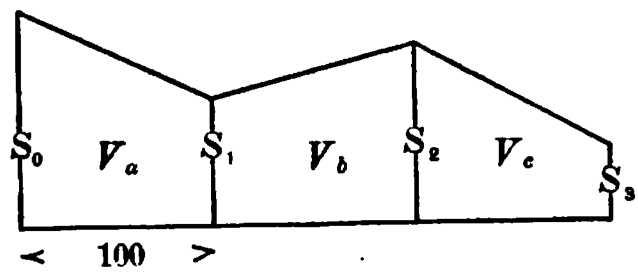
$$= \frac{l^2}{12 \times 27} \cdot \frac{A_1 - A_0}{V_{100} \times \frac{l}{100}}$$

$$= \frac{100\ l}{12 \times 27} \cdot \frac{A_1 - A_0}{V_{100}}$$

$$x_{g_{100}} = \frac{100 \times 100}{12 \times 27} \cdot \frac{A_1 - A_0}{V_{100}}$$

$$x_{g_l} = x_{g_{100}} \cdot \frac{l}{100} \tag{207}$$

297. For a *series of sections*, each 100 ft., a correction may be applied to obtain the correction in haul for the entire mass.



Let $X_c =$ cent. of grav. for entire mass (approximately), found by using for each section $c.g.$ at $\frac{l}{2}$

$H_a =$ approx. total haul $= V \times X_c$

$X =$ true dist. to $c.g.$ of entire mass

$H =$ correct total haul $= V \times X$

$S_0 = \frac{50}{27} A_0$, $S_1 = \frac{50}{27} A_1$, $S_2 =$ etc., as taken from tables or diagrams.

When all sections are of uniform length, 100′ as in figure above, approximate total haul

$$H_a = X_c V = \frac{100}{2}(V_a \qquad + 3\,V_b \qquad + 5\,V_c)$$

Correct total haul

$$H = XV = V_a\left(\frac{100}{2} + x_{ga}\right) + V_b\left(3\frac{100}{2} + x_{gb}\right) + V_c\left(5\frac{100}{2} + x_{gc}\right)$$

$$H - H_a = \qquad V_a x_{ga} \quad + \quad V_b x_{gb} \qquad + V_c x_{gc}$$

$$= \frac{100}{6}\left[V_a\frac{S_0 - S_1}{V_a} + \quad V_b\frac{S_1 - S_2}{V_b} \quad + V_c\frac{S_2 - S_3}{V_c}\right]$$

$$= \frac{100}{6}(S_0 - S_3)$$

Or for a more general form

$$H - H_a = \frac{100}{6}(S_0 - S_n) = \text{correction in total haul.} \qquad (208)$$

This should be in cu. yds. hauled 100 ft.

CHAPTER XVII.

MASS DIAGRAM.

298. Many questions of "haul" may be usefully treated by a graphical method which will be designated the "Mass Diagram."

The construction of the "Mass Diagram" will be more clearly understood from an example than from a general description.

Consider the earthwork shown by the profile on p. 206, consisting of alternate "cut" and "fill." To show the work of constructing the "diagram" in full, the quantities are calculated throughout, but for convenience, "level sections" are used and prismoidal correction disregarded. In actual practice, the solidities will have been calculated for the actual notes taken. Allowance should be made for the fact that earth placed in fill shrinks. The allowance to be made in column 5 of table will depend on how the work is to be handled. In column 5 opposite, it is assumed that, without changing the notes, additional material is placed in the fill to provide for shrinkage or settlement, which accords with common practice; and 5 per cent shrinkage is used here.

299. In the table, p. 205, columns 1 and 2 explain themselves.

3d column gives values of S from tables.

4th column gives values of S_{100} or S_l for each section, and with sign $+$ for cut or $-$ for fill.

5th column shows fills after 5 per cent shrinkage.

6th column gives the total, or the sum of solidities up to each station; and in getting this total, each $+$ solidity is added and each $-$ solidity is subtracted, as appears in the table from the results obtained.

Having completed the table, the next step is the construction of the "Mass Diagram," page 206. In the figure shown there, each station line is projected down, and the value from column 6, corresponding to each station, is platted to scale as an offset from the base line at that station, all $+$ quantities above the line, and all $-$ quantities below the line. The points thus found are joined, and the result is the "Mass Diagram."

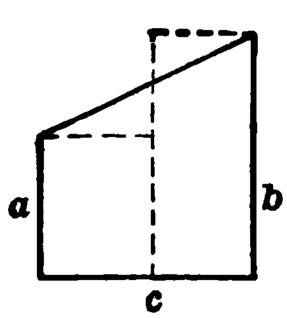
Station.	Center Heights.	Solidity for 50′ due to Center Height (from Tables).	Solidity for Section.	Fills +5 Per Cent Shrinkage.	Solidity Totals.
0	0	0			0
1	+ 1.7	71	+ 71		+ 71
2	+ 2.7	120	+ 191		+ 262
3	0	0	+ 120		+ 382
4	− 3.2	111	− 111	− 117	+ 265
5	− 4.9	194	− 305	− 320	− 55
6	− 2.8	94	− 288	− 302	− 357
7	0	0	− 94	− 99	− 456
8	+ 2.4	105	+ 105		− 351
9	+ 4.5	223	+ 328		− 23
10	+ 2.5	110	+ 333		+ 310
11	0	0	+ 110		+ 420
12	− 2.9	98	− 98	− 103	+ 317
13	− 5.1	205	− 303	− 318	− 1
14	− 7.4	344	− 549	− 576	− 577
15	− 8.1	392	− 736	− 773	− 1350
16	− 4.1	153	− 545	− 572	− 1922
17	0	0	− 153	− 161	− 2083
18	+ 2.6	115	+ 115		− 1968
19	+ 3.6	169	+ 284		− 1684
20	+ 4.9	248	+ 417		− 1267
21	+ 6.7	373	+ 621		− 646
22	+ 7.5	434	+ 807		+ 161
23	+ 5.2	268	+ 702		+ 863
24	+ 2.4	105	+ 373		+ 1236
25	0	0	+ 105		+ 1341
26	− 3.5	125	− 125	− 131	+ 1210
27	− 5.7	238	− 363	− 381	+ 829
28	− 4.9	194	− 432	− 454	+ 375
29	− 2.5	82	− 276	− 290	+ 85
30	0	0	− 82	− 86	− 1

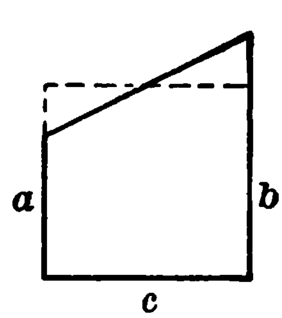
300. It will follow, from the methods of calculation and construction used, that the "Mass Diagram" will have the following properties, which can be understood by reference to the profile and diagram, page 206.

1. Grade points of the profile correspond to maximum and minimum points of the diagram.
2. In the diagram, ascending lines mark excavation, and descending lines embankment.
3. The difference in length between any two vertical ordinates of the diagram is the solidity between the points (stations) at which the ordinates are erected.
4. Between any two points where the diagram is intersected by any horizontal line, excavation equals embankment.
5. The area cut off by any horizontal line is the measure of the "haul" between the two points cut by that line.

301. It may be necessary to explain the latter point at somewhat greater length.

Any quantity (such as dimension, weight, or volume) is often represented graphically by a line; in a similar way, the product of two quantities (such as volume into distance, or as foot pounds) may be represented or measured by an area. In the case of a figure other than a rectangle, the value, or product measured by this area, may be found by cutting up the area by lines, and these lines may be vertical lines representing volumes or horizontal lines representing distance. The result will be the same in either case. An example will illustrate.



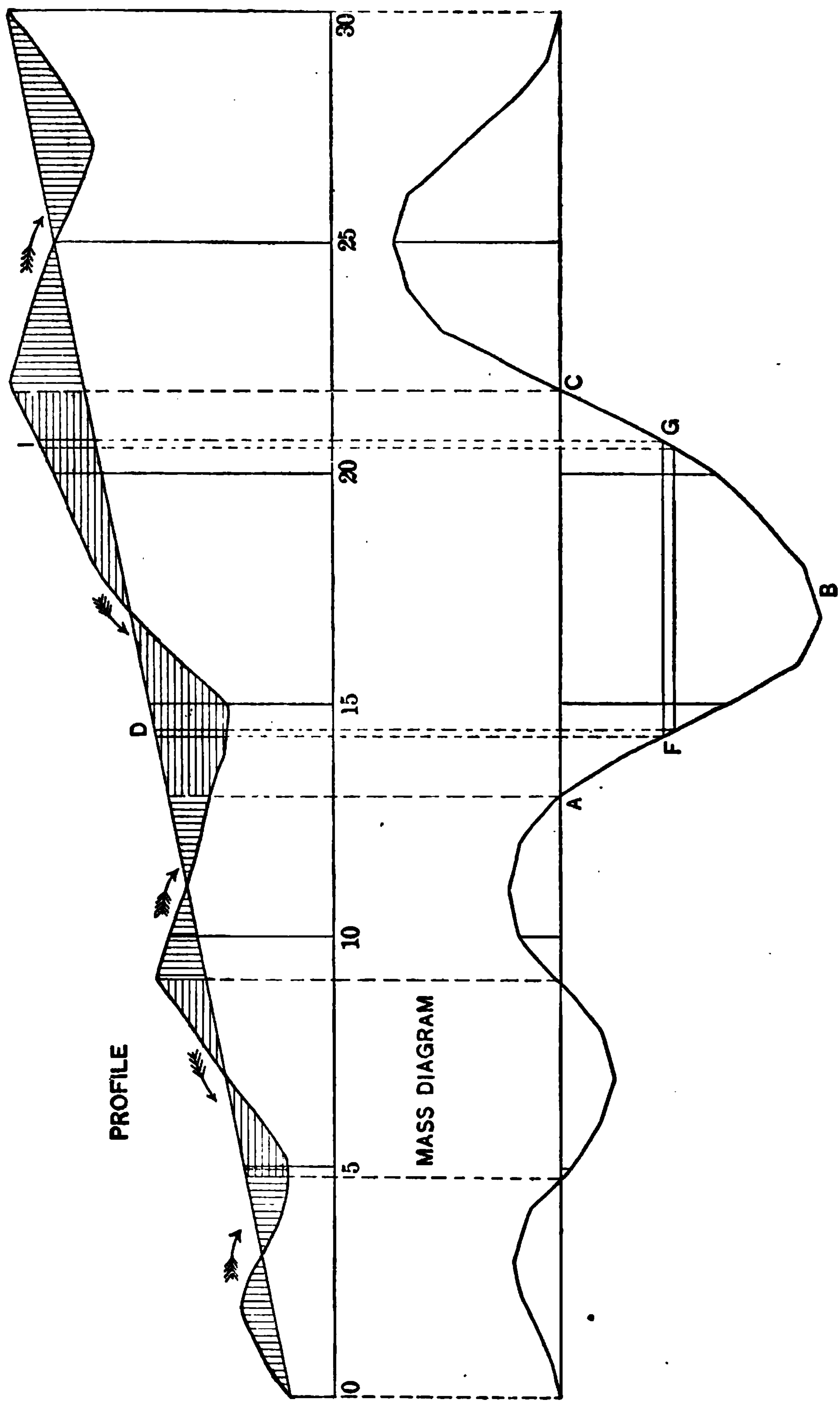


In the two figures let a and b represent pounds, c " feet, and the area of the trapezoid represent a certain number of foot pounds. The trapezoid may be resolved into rectangles by the use of a vertical line, as shown in Fig. 1, or by a horizontal line, as in Fig. 2.

In Fig. 1, the area is $a \times \frac{c}{2} + b \times \frac{c}{2}$

In Fig. 2, the area is $\frac{a+b}{2} \times c$

the result of course being the same in both cases.


PROFILE
MASS DIAGRAM
0
5
10
15
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25
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A
B
C
D
F
G

302. In an entirely similar way, the area ABC (p. 208) represents the "haul" of earthwork (in cu. yds. moved 100 ft.) between A and C, and this area may be calculated by dividing it by a series of vertical lines representing solidities, as shown above G and F. That this area represents the haul between A and C may be shown as follows: —

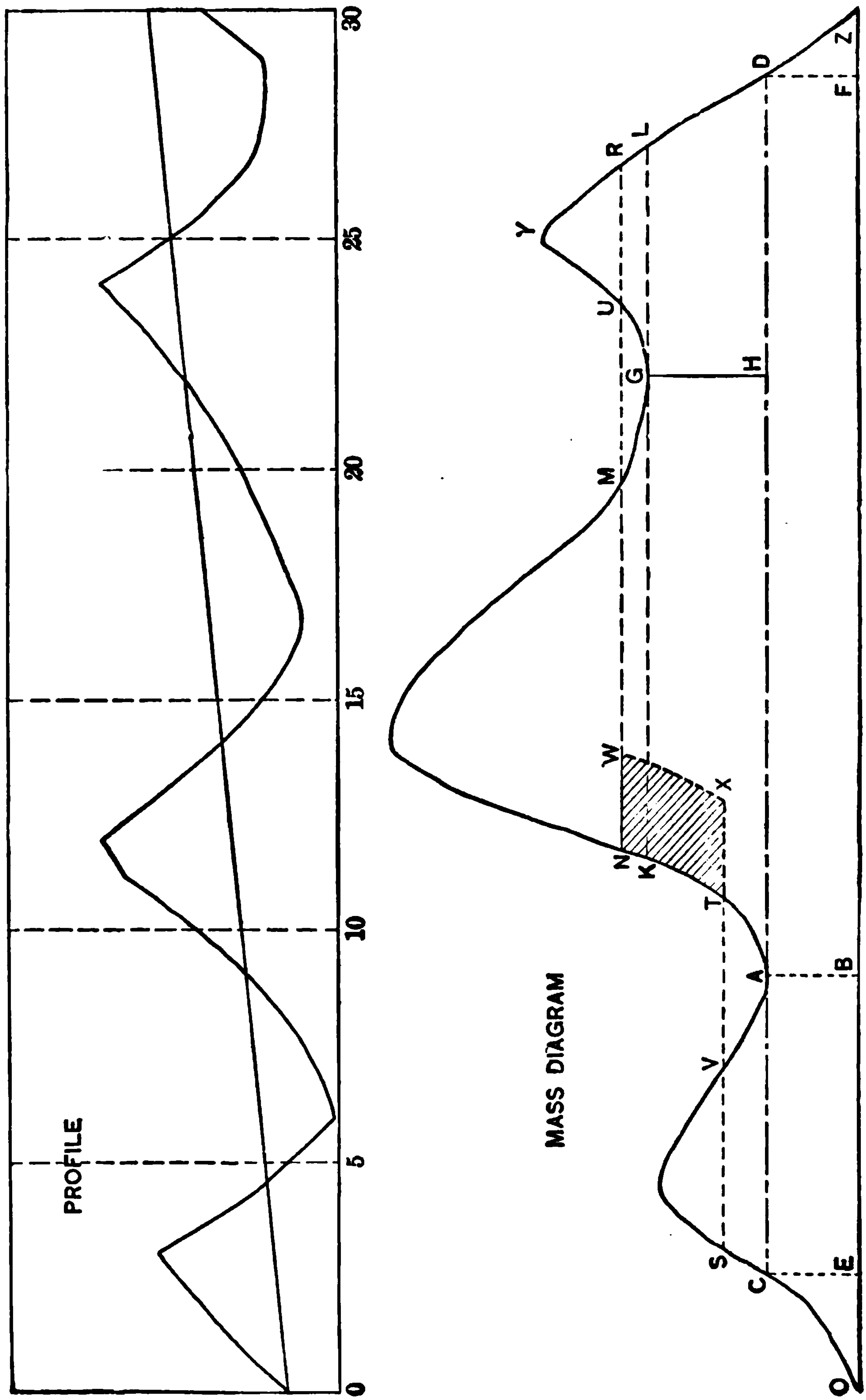
Take any elementary solidity dS at D. Project this down upon the diagram at F, and draw the horizontal lines FG.

Between the points F and G (or between D and I), therefore, excavation equals embankment, and the mass dS must be hauled a distance FG, and the amount of "haul" on dS will be $dS \times$ FG, measured by the trapezoid FG. Similarly with any other elementary dS.

The total "haul" between A and C will be measured by the sum of the series of trapezoids, or by the area ABC. This area is probably most conveniently measured by the trapezoids formed by the vertical lines representing solidities. The average length of haul will be this area divided by the total solidity (represented in this case on p. 206 by the longest vertical line, 2083).

303. The construction of the "Mass Diagram" as a series of trapezoids involves the assumption that the center of gravity of a section of earthwork lies at its mid-section, which is only approximately correct since S for the first 50 ft. will seldom be exactly the same as S for the second 50 ft. of a section 100 ft. long. If the lines joining the ends of the vertical lines be made a curved line, the assumption becomes more closely accurate, and if the area be calculated by "Simpson's Rule," or by planimeter, results closely accurate will be reached.

It will be further noticed that hill sections in the "diagram" represent haul forward on the profile, and valley sections haul backward. The mass diagram may therefore be used to indicate the methods by which the work shall be performed; whether excavation at any point shall be hauled forward or backward; and, more particularly, to show the point where backward haul shall cease and forward haul begin, as indicated in the figure, p. 208, which shows a very simple case, the cuts and fills being evenly balanced, and no haul over 900 feet, with no necessity for either borrowing or wasting.


PROFILE
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MASS DIAGRAM
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U
Y
R
L
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Z

304. In the figure, page 210, the excavation from Sta. 0 to 14 is very much in excess of embankment, and *vice versa* from Sta. 14 to 30. The mass diagram indicates a haul of nearly 3000 ft. for a large mass of earthwork, measured by the ordinate AB. It will not be economical to haul the material 3000 ft.; it is better to "waste" some of the material near Sta. 0, and to "borrow" some near Sta. 30, if this be possible, as is commonly the case.

If we draw the line CD, the cut and fill between C and D will still be equal, and the volume of cut measured by CE can be wasted, and the equal volume of fill measured by DF can be borrowed to advantage. It can be seen that there is still a haul of nearly 2000 ft. (from A to D) on the large mass of earthwork measured by GH. It is probable that it will not pay to haul the mass GH, or any part of it, as far as AD.

305. We must find the limit beyond which it is unprofitable to *haul* material rather than *borrow* and *waste*.

Let c = cost of 1 cu. yd. excavation or embankment.
h = cost of haul on 1 cu. yd. hauled 100 ft.
n = length of haul in "stations" of 100 ft. each.

Then, when 1 cu. yd. of excavation is wasted, and 1 cu. yd. of embankment is borrowed,

$$\text{cost} = 2c$$

When 1 cu. yd. of excavation is hauled into embankment,

$$\text{cost} = c + nh$$

The limit of profitable haul is reached when

$$2c = c + nh$$

or when

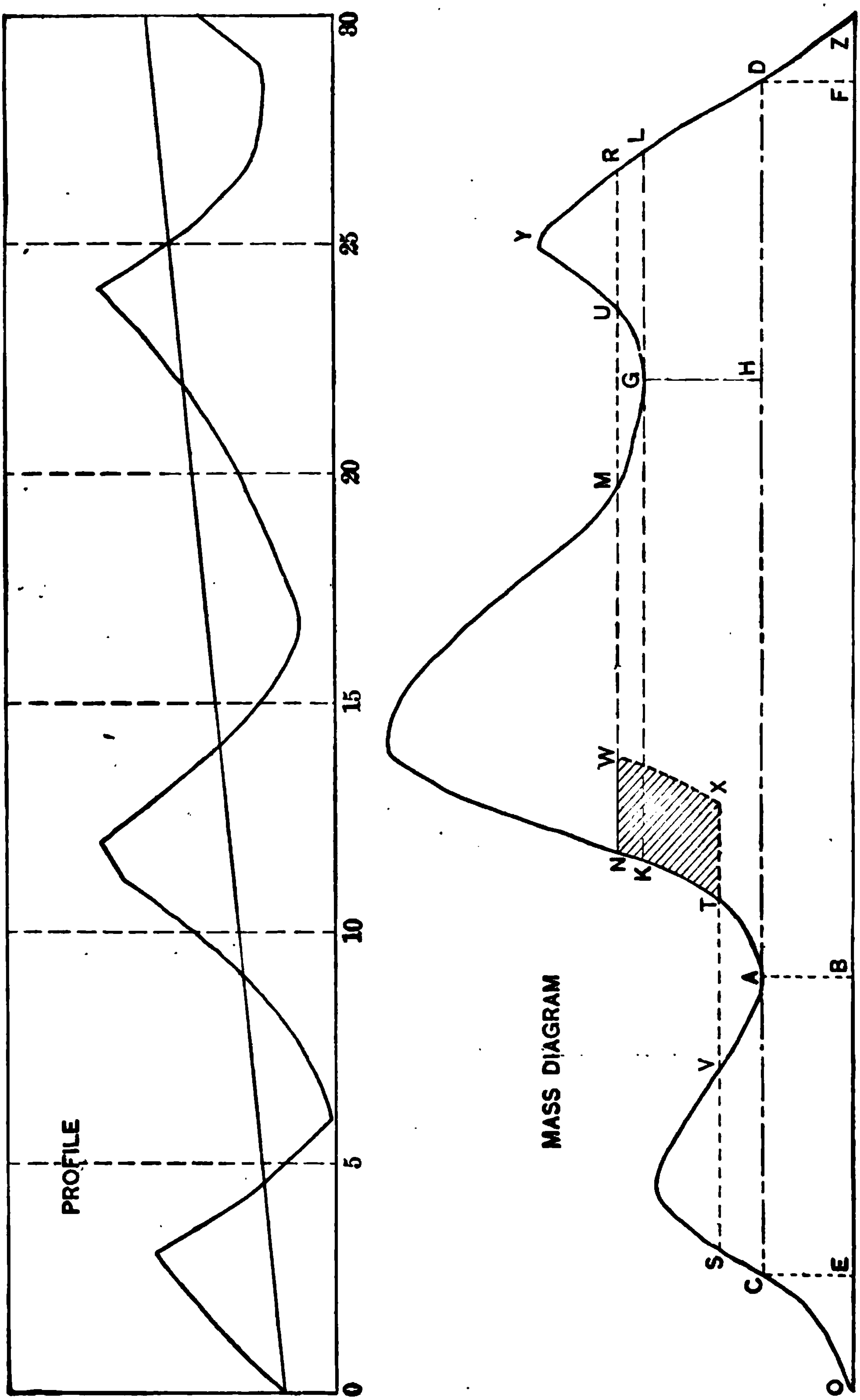
$$n = \frac{c}{h} \tag{209}$$

Example. When excavation or embankment is 18 cents per cu. yd., and haul is $1\frac{1}{2}$ cents,

$$n = \frac{18}{1.5} = 12 \text{ stations}$$

When $c = 16$ and $h = 2$

then $n = 8$ stations


PROFILE
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MASS DIAGRAM
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T
K
N
X
W
M
G
H
U
Y
R
L
D
F
Z

306. In the former case (1200 ft. haul) we should draw in mass diagram (p. 212) the line KGL. Here KG is less than 1200 ft. The line should not be lower than G, for in that case the haul would be nearly as great as KL, or more than 1200 ft.

In the latter case (800 ft. haul) the line would be carried up to a point where NM = 800 ft. The masses between N and A, also C and O, can better be wasted than hauled, and the masses between M and G, also L and Z, can better be borrowed than hauled (always provided that there are suitable places at hand for borrowing and wasting).

Next, produce NM to R. The number of yards borrowed will be the same whether taken at RZ or at MG + LZ. That arrangement of work which gives the smallest "haul" (product of cu. yds. × distance hauled) is the best arrangement. The "haul" in one case is measured by GLRYU, and in the other by MGU + UYR. If MGU is less than GLRU, then it is cheaper to borrow (*a*) RZ rather than (*b*) MG + LZ.

In a similar way material NT and SO can be wasted more economically than NA and CO.

The most economical position for the line MR is when MU = UR. For ST, when SV = VT. For any change from these positions of MR and ST will show an increase of area representing "haul."

307. The case is often not as simple as that here given. Very often the material borrowed or wasted has to be hauled beyond the limit of "free haul." The limit beyond which it is unprofitable to haul will vary according to the length of haul on the borrowed or wasted material; the limit will, in general, be increased by the length of haul on the borrowed or wasted material. The haul on wasted or borrowed material, as NT, may be shown graphically by NTXW, where NW = TX shows the length of haul, and NTXW the "haul" (mass × distance).

The mass diagram can be used also for finding the limit of "free haul" on the profile, and various applications will suggest themselves to those who become familiar with its use and the principles of its construction. Certainly one of its most important uses is in allowing "haul" and "borrow and waste" to be studied by a diagram giving a comprehensive view of the whole situation. There are few if any other available methods of accomplishing this result.

308. When material is first taken out in excavation, it generally occupies more space than was originally the case. When placed in embankment, it commonly shrinks somewhat and eventually occupies less space than originally. Wherever, from any cause, the material put into embankment will occupy more space or less space than it did in excavation, the quantities in embankment should be corrected before figuring haul or constructing a Mass Diagram, and a column should be shown for this as is done in Table p. 205.

309. Many engineers write their contracts and specifications without a clause allowing payment for "haul" or "overhaul." Nevertheless it appears that it is the more common practice to insert a clause providing for payment for overhaul. A canvass on this subject by the American Railway Engineering and Maintenance of Way Association in 1905 showed this practice to prevail in the proportion of 73 to 37. The free haul limit of 500 ft. seemed to meet with greater favor than any other.

Where an "overhaul" clause is inserted in a contract, the basis of payment has varied on different railroads. In one method, not recommended, the total haul is to be computed; from this shall be deducted for free haul the total "yardage" multiplied by the length of the free haul limit. Under this system, with a 500 ft. free haul limit, there might be 10,000 cu. yds. of earth hauled (all of it) more than 500 ft., or an average of 600 ft.; yet if there were another 10,000 cu. yds. hauled an average of 300 ft., there would be no payment whatever for overhaul; the average haul would be less than 500 ft. Unless the specifications clearly show that this method is to be used, it is unfair as well as unsatisfactory to the contractor.

What seems a logical and satisfactory provision is that recommended by the American Railway Engineering and Maintenance of Way Association by a letter ballot vote of 134 to 23 (announced in March, 1907). This is as follows: —

"No payment will be made for hauling material when the length of haul does not exceed the limit of free haul, which shall be _____ feet.

"The limits of free haul shall be determined by fixing on the profile two points, one on each side of the neutral grade point, one in excavation and the other in embankment, such that the distance between them equals the specified free haul limit, and

the included quantities of excavation and embankment balance. All haul on material beyond this free haul limit will be estimated and paid for on the basis of the following method of computation, viz.: —

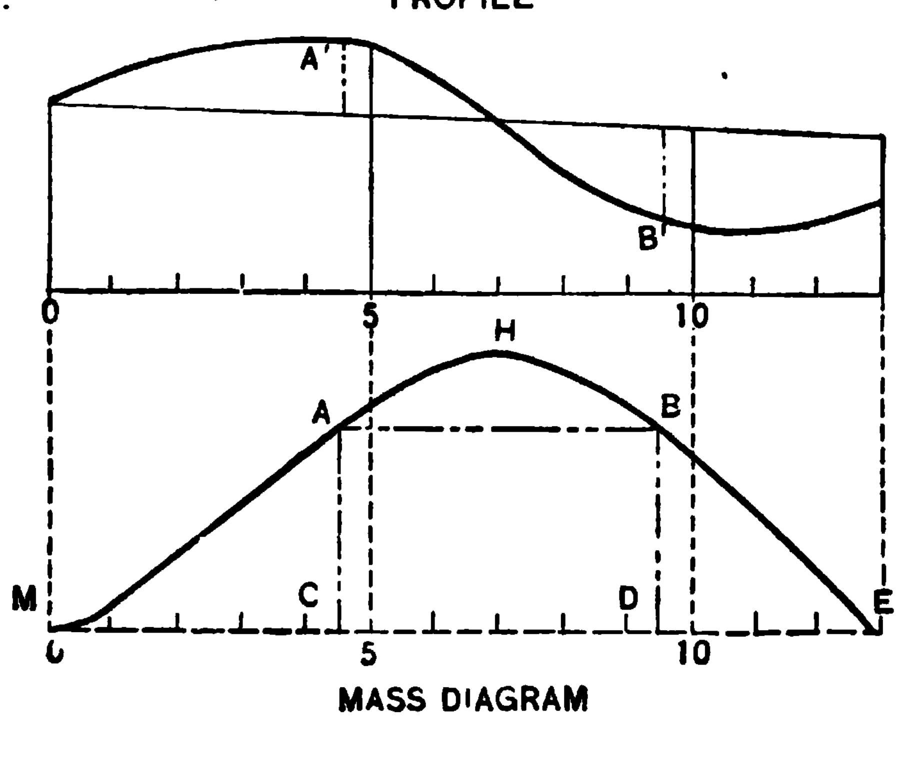
"All material within this limit of free haul will be eliminated from further consideration.

"The distance between the center of gravity of the remaining mass of excavation and center of gravity of the resulting embankment, less the limit of free haul as above described, shall be the length of overhaul, and the compensation to be rendered therefor will be determined by multiplying the yardage of the remaining mass as above described, by the length of the overhaul. Payment for the same will be by units of one cubic yard hauled one hundred feet.

"When material is obtained from borrow-pits along the embankment, and runways are constructed, the haul shall be determined by the distance the team necessarily travels. The overhaul on material thus hauled shall be determined by multiplying the yardage so hauled by one half the round distance made by the team less the free haul distance. The runways will be established by the engineer."

310. This statement as to the method of figuring overhaul is explained very simply by the Mass Diagram below. The length of AB is that of the free haul limit (500 ft. in figure). The free haul is shown in the area ACDBHA. The amount of overhaul to be paid for is shown in 2 parts, ACM, BDE.

PROFILE



MASS DIAGRAM

311. The diagram on the page opposite shows a sketch of a profile and the corresponding mass diagram; illustrating further the method of studying questions of haul, borrow, and waste. For this purpose it is assumed that the limit of economical haul is 1000 ft., and the lines on the mass diagram are adjusted accordingly.

(*a*) Line AB = 1000 ft. and can go no lower because the limit of 1000 ft. would be exceeded; nor higher because the waste near A and the borrow near B would be increased.

(*b*) Line CDE is placed so that CD = DE; the sum of the two borrows (between B and C, and between E and F) is the same for any practical position of CDE; the sum of the two areas CRD and DSE is a minimum when CD = DE.

(*c*) Line FG = 1000 ft. and can go no higher without exceeding 1000 ft. nor lower without increasing borrow near F and waste near G.

(*d*) Line HJ can go no lower without exceeding 1000 ft. nor higher without increasing waste near H and borrow near J.

(*e*) Line JKLM can go no higher because the borrow between M and N would be increased. The area above JK and LM could be decreased materially, and the area below KL increased only slightly, by moving JKLM higher, but the loss due to the increased amount of borrow between M and N would far exceed the gain in the haul item.

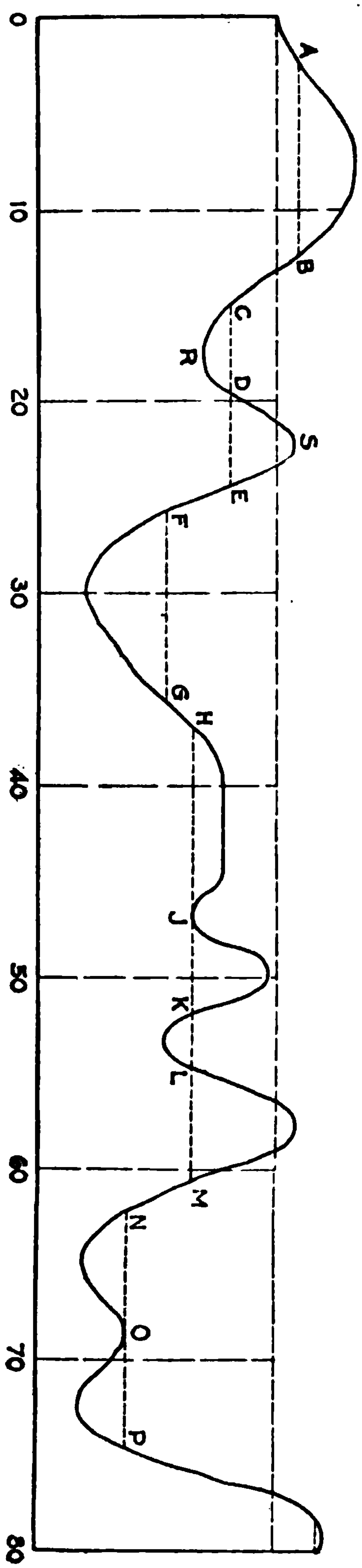
(*f*) Line NOP can go no higher without exceeding 1000 ft.; it can go no lower without increasing the borrow between M and N, and also the waste beyond P.

(*g*) If the profile were continued beyond station 80, it is quite possible that the material indicated as waste could be utilized in fill, or part of it so utilized.

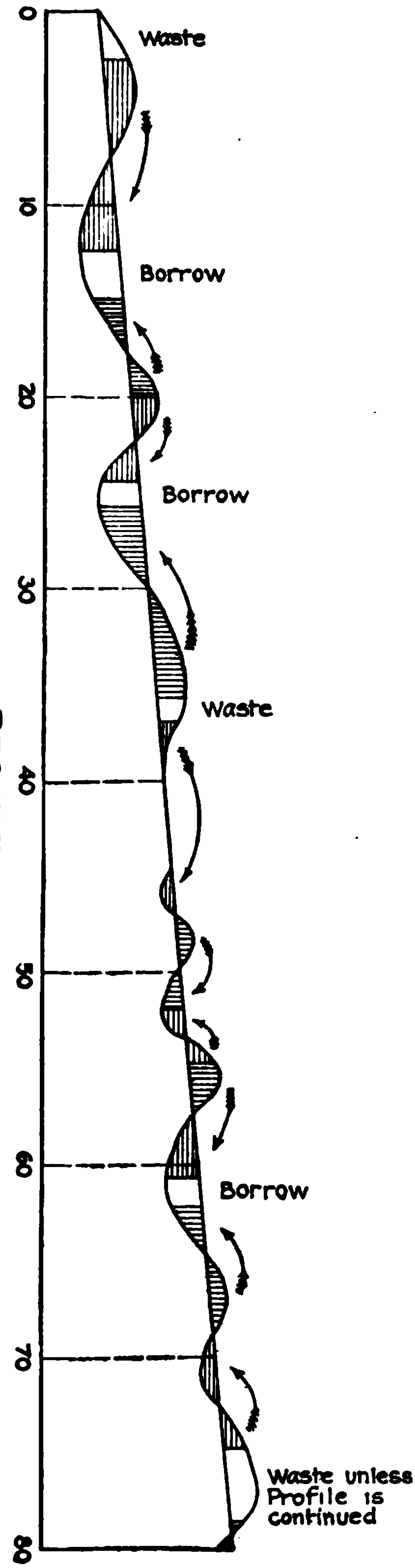
(*h*) As the profile is shown, there is a small amount of cut carried into fill close to station 80.

(*i*) The projections of the points A, B, C, D, etc., up to the profile, serve to show where material should be wasted, where borrowed; what material should be carried forward, what backward. The study of the mass diagram has shown that the arrangement adopted is the most economical.

The exact stations of the points A, B, C, D, etc., can be determined accurately from the cross-section notes and the volumes of earthwork already computed, if this should seem desirable.



MASS DIAGRAM



PROFILE

40

30

20

10

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FIELD AND OFFICE TABLES

SPECIALLY APPLICABLE TO RAILROADS

BY

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REVISED EDITION

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PREFACE

It is hoped that these tables will be found more complete and perfect than those which have preceded. Among them are convenient tables for easement curves and for earthwork computation, several of which are altogether new. These include the "Cubic Spiral" easement curve, which is very simple, being arranged for a uniform chord length of 30 feet, and giving all deflection angles for a large variety of spirals; also the "Offsets from Tangent for a 10° Curve" and "Angles Proportionate to Squares of Distances," both of which are specially applicable to easement curves, but should be found useful for other purposes. The two latter allow the rapid and simple working of spirals of any length or for any set-off from the tangent.

The tables for Earthwork Computation should meet with favor. Those for regular three-level sections and for prismoidal correction are based upon tables used for computing the earthwork on many hundred miles on a prominent western railroad, and that for triangular prisms is similar in principle to that for prismoidal correction.

Other tables seldom found in books suitable for field use are "Acres for Strip 100 Feet Wide," "Metric Curves," "Velocity Heights," and "Mean Refractions in Declination," while the "Stadia Reduction Tables" are more complete than those common in field tables.

The table for "Tangent Distances for a 1° Curve" gives values for every minute up to 96° and the table of "Corrections" is full enough to render interpolation unnecessary. This will allow greater speed and the saving of much time for an entire field party.

There are many points of arrangement and typography which are intended to facilitate work or render errors less probable. Great care has been taken both in computing and proof-reading to secure absence from error. The plate-proof has been twice read under the author's direction, and other tests applied which have required the use (in adding) of every figure in the tables. The opportunity for comparison with other published tables and the running down of discrepancies has given opportunity for a high degree of accuracy, and these tables are believed to be superior in this respect.

The "Barometric Heights" are Professor Airy's and the "Stadia Reductions" are Winslow's from the "Reports of the Pennsylvania Geological Survey." The "Logarithms" and "Sines, Cosines, Tangents and Cotangents," both natural and logarithmic,

are taken from the copyrighted "Wells' Six Place Logarithmic Tables" by permission of Prof. Webster Wells and of D. C. Heath & Co., his publishers; and the Refractions in Declination," also copyrighted, from the "Manual" published by W. and L. E. Gurley, who have permitted their use. Almost, if not quite, all other tables have been calculated anew; seven place tables of logarithms and logarithmic functions have been largely used, but all numbers doubtful in the last place have been worked out by ten place tables which have necessarily been in very frequent use. No pains have been spared to make the last figure correct. The author desires to thank every one who has helped in the preparation of this book by suggestion or otherwise, and especially Mr. C. B. Breed, of the Massachusetts Institute of Technology, for frequent advice and assistance in arrangement and preparation of work; to Mr. E. S. Manson, Jr., S. M., who computed some of the most important tables, including Tables I, III, XV; to Miss V. W. Porter for very faithful and efficient work both in computations and comparisons and proof-reading; and to W. & L. E. Gurley, to D. C. Heath & Co., and to Prof. Webster Wells for their courteous permission to use their books as stated above.

These tables will be published separately and also in combination with the Author's book on "Railroad Curves and Earthwork."

July, 1903.

PREFACE TO SECOND EDITION

New tables have been prepared, adapted to the use of the Spiral of the Am. Ry. Eng. Ass'n, and the old tables for Spirals discontinued. A new table for finding the difference between the lengths of circular arcs and chords is specially useful for curved boundary lines, either on streets or on railroad right of way. Another addition has been the tables of split switch turnouts, both for theoretical and for practical leads, adopted as standards by the Am. Ry. Eng. Ass'n. The table for Stadia Reductions has given place to one better arranged, copyrighted by Breed and Hosmer in their book on Surveying, and used here by their permission.

C. FRANK ALLEN.

January, 1914.

LIST OF TABLES

TABLE I.—RADII AND THEIR LOGARITHMS.

Deg. D.	Radius R.	Log. R.	Deg. D.	Radius R.	Log. R.	Deg. D.	Radius R.	Log. R.
0° 0′	∞	∞	1° 0′	5729.65	3.758128	2° 0′	2864.93	3.457115
1	343774.68	5.536274	1	5635.72	.750950	1	2841.26	.453511
2	171887.34	.235244	2	5544.83	.743888	2	2817.97	.449937
3	114591.56	.059153	3	5456.82	.736939	3	2795.06	.446392
4	85943.67	4.934214	4	5371.56	.730100	4	2772.53	.442876
5	68754.94	4.837304	5	5288.92	3.723367	5	2750.35	3.439388
6	57295.79	.758123	6	5208.79	.716737	6	2728.52	.435928
7	49110.68	.691176	7	5131.05	.710206	7	2707.04	.432495
8	42971.84	.633184	8	5055.59	.703772	8	2685.89	.429089
9	38197.20	.582031	9	4982.33	.697432	9	2665.08	.425710
10	34377.48	4.536274	10	4911.15	3.691183	10	2644.58	3.422356
11	31252.26	.494881	11	4841.98	.685023	11	2624.39	.419029
12	28647.90	.457093	12	4774.74	.678949	12	2604.51	.415727
13	26444.22	.422331	13	4709.33	.672959	13	2584.93	.412449
14	24555.35	.390146	14	4645.69	.667051	14	2565.65	.409197
15	22918.33	4.360183	15	4583.75	3.661221	15	2546.64	3.405968
16	21485.94	.332154	16	4523.44	.655469	16	2527.92	.402763
17	20222.06	.305825	17	4464.70	.649792	17	2509.47	.399582
18	19098.61	.281002	18	4407.46	.644189	18	2491.29	.396424
19	18093.43	.257521	19	4351.67	.638656	19	2473.37	.393289
20	17188.76	4.235244	20	4297.28	3.633194	20	2455.70	3.390176
21	16370.25	.214055	21	4244.23	.627799	21	2438.29	.387085
22	15626.15	.193852	22	4192.47	.622470	22	2421.12	.384016
23	14946.75	.174547	23	4141.96	.617206	23	2404.19	.380969
24	14323.97	.156064	24	4092.66	.612005	24	2387.50	.377943
25	13751.02	4.138335	25	4044.51	3.606866	25	2371.04	3.374938
26	13222.13	.121302	26	3997.48	.601787	26	2354.80	.371954
27	12732.43	.104911	27	3951.54	.596766	27	2338.78	.368990
28	12277.70	.089117	28	3906.64	.591803	28	2322.98	.366046
29	11854.33	.073877	29	3862.74	.586896	29	2307.39	.363122
30	11459.19	4.059154	30	3819.83	3.582044	30	2292.01	3.360217
31	11089.54	.044914	31	3777.85	.577245	31	2276.84	.357332
32	10743.00	.031125	32	3736.79	.572499	32	2261.86	.354466
33	10417.45	.017762	33	3696.61	.567804	33	2247.08	.351618
34	10111.06	.004797	34	3657.29	.563160	34	2232.49	.348789
35	9822.18	3.992208	35	3618.80	3.558564	35	2218.09	3.345979
36	9549.34	.979973	36	3581.10	.554017	36	2203.87	.343187
37	9291.25	.968074	37	3544.19	.549517	37	2189.84	.340412
38	9046.75	.956492	38	3508.02	.545063	38	2175.98	.337655
39	8814.78	.945212	39	3472.59	.540654	39	2162.30	.334915
40	8594.42	3.934216	40	3437.87	3.536289	40	2148.79	3.332193
41	8384.80	.923493	41	3403.83	.531968	41	2135.44	.329488
42	8185.16	.913027	42	3370.46	.527690	42	2122.26	.326799
43	7994.81	.902808	43	3337.74	.523453	43	2109.24	.324127
44	7813.11	.892824	44	3305.65	.519257	44	2096.39	.321471
45	7639.49	3.883064	45	3274.17	3.515101	45	2083.68	3.318832
46	7473.42	.873519	46	3243.29	.510985	46	2071.13	.316208
47	7314.41	.864179	47	3212.98	.506908	47	2058.73	.313600
48	7162.03	.855036	48	3183.23	.502868	48	2046.48	.311008
49	7015.87	.846081	49	3154.03	.498866	49	2034.37	.308431
50	6875.55	3.837308	50	3125.36	3.494900	50	2022.41	3.305869
51	6740.74	.828708	51	3097.20	.490970	51	2010.59	.303323
52	6611.12	.820275	52	3069.55	.487075	52	1998.90	.300791
53	6486.38	.812002	53	3042.39	.483215	53	1987.35	.298274
54	6366.26	.803885	54	3015.71	.479389	54	1975.93	.295771
55	6250.51	3.795916	55	2989.48	3.475596	55	1964.64	3.293283
56	6138.90	.788091	56	2963.72	.471836	56	1953.48	.290809
57	6031.20	.780404	57	2938.39	.468109	57	1942.44	.288349
58	5927.22	.772851	58	2913.49	.464413	58	1931.53	.285902
59	5826.76	.765427	59	2889.01	.460749	59	1920.75	.283470
60	5729.65	3.758128	60	2864.93	3.457115	60	1910.08	3.281051

TABLE I.—RADII AND THEIR LOGARITHMS.

	dius R.	I		Radius R.	I[illegible].	Deg. D.	Radiu R.	
3° 0′	1910.08	3.281051	4° 0′	1432.69	3.156151	5° 0′	1146.28	3.059290
1	1899.53	.278645	1	1426.74	.154346	1	1142.47	.057846
2	1889.09	.276253	2	1420.85	.152548	2	1138.69	.056407
3	1878.77	.273874	3	1415.01	.150758	3	1134.94	.054972
4	1868.56	.271508	4	1409.21	.148975	4	1131.21	.053542
5	1858.47	3.269155	5	1403.46	3.147200	5	1127.50	3.052116
6	1848.48	.266814	6	1397.76	.145431	6	1123.82	.050696
7	1838.59	.264486	7	1392.10	.143670	7	1120.16	.049280
8	1828.82	.262170	8	1386.49	.141916	8	1116.52	.047868
9	1819.14	.259867	9	1380.92	.140169	9	1112.91	.046462
10	1809.57	3.257576	10	1375.40	3.138430	10	1109.33	3.045059
11	1800.10	.255296	11	1369.92	.136697	11	1105.76	.043660
12	1790.73	.253029	12	1364.49	.134971	12	1102.22	.042268
13	1781.45	.250774	13	1359.10	.133251	13	1098.70	.040880
14	1772.27	.248530	14	1353.75	.131539	14	1095.20	.039495
15	1763.18	3.246297	15	1348.45	3.129833	15	1091.73	3.038115
16	1754.19	.244077	16	1343.18	.128134	16	1088.28	.036740
17	1745.29	.241867	17	1337.96	.126442	17	1084.85	.035368
18	1736.48	.239669	18	1332.77	.124756	18	1081.44	.034002
19	1727.75	.237481	19	1327.63	.123077	19	1078.05	.032639
20	1719.12	3.235305	20	1322.53	3.121404	20	1074.68	3.031281
21	1710.57	.233140	21	1317.46	.119738	21	1071.34	.029927
22	1702.10	.230985	22	1312.43	.118078	22	1068.01	.028577
23	1693.72	.228841	23	1307.45	.116424	23	1064.71	.027231
24	1685.42	.226707	24	1302.50	.114777	24	1061.43	.025890
25	1677 20	3.224584	25	1297 58	3.113136	25	1058.16	3.024552
26	1669.06	.222472	26	1292.71	.111501	26	1054.92	.023219
27	1661.00	.220369	27	1287.87	.109872	27	1051.70	.021890
28	1653.02	.218277	28	1283.07	.108249	28	1048.49	.020565
29	1645.11	.216194	29	1278.30	.106632	29	1045.31	.019244
30	1637.28	3.214122	30	1273.57	3.105022	30	1042.14	3.017927
31	1629.52	.212060	31	1268.87	.103417	31	1039.00	.016614
32	1621.84	.210007	32	1264.21	.101818	32	1035.87	.015305
33	1614.22	207964	33	1259.58	.100225	33	1032.76	.013999
34	1606.68	.205930	34	1254 98	.098638	34	1029.67	.012698
35	1599.21	3.203906	35	1250.42	3.097057	35	1026.60	3.011401
36	1591.81	.201892	36	1245.89	.095481	36	1023.55	.010107
37	1584.48	.199886	37	1241.40	.093912	37	1020.51	.008818
38	1577 21	.197890	38	1236.94	.092347	38	1017.49	.007532
39	1570.01	.195903	39	1232.51	.090789	39	1014.50	.006250
40	1562.88	3.193925	40	1228.11	3.089236	40	1011.51	3.004972
41	1555.81	.191956	41	1223.74	.087688	41	1008.55	.003698
42	1548.80	189996	42	1219.40	.086147	42	1005.60	.002427
43	1541 86	.188045	43	1215.09	.084610	43	1002.67	.001160
44	1534.98	.186103	44	1210.82	.083079	44	999.76	2.999897
45	1528.16	3.184169	45	1206.57	3.081553	45	996.87	2 998637
46	1521.40	.182244	46	1202.36	.080033	46	993.99	.997381
47	1514.70	.180327	47	1198.17	.078518	47	991.13	.996129
48	1508.06	.178419	48	1194.01	.077008	48	988.28	.994880
49	1501.48	.176519	49	1189.88	.075504	49	985.45	.993635
50	1494.95	3.174627	50	1185.78	3.074005	50	982.64	2.992393
51	1488.48	.172744	51	1181.71	072511	51	979.84	.991155
52	1482 07	.170868	52	1177.66	.071022	52	977.06	.989921
53	1475.71	.169001	53	1173.65	.069538	53	974.29	.988690
54	1469.41	.167142	54	1169.66	.068059	54	971.54	.987463
55	1463.16	3.165291	55	1165.70	3.066585	55	968.81	2.986239
56	1456.96	.163447	56	1161.76	.065116	56	966.09	.985018
57	1450.81	.161612	57	1157.85	.063653	57	963.39	.983801
58	1444.72	.159784	58	1153.97	062194	58	960.70	.982587
59	1438.68	.157963	59	1150.11	.060740	59	958.02	.981377
60	1432.69	3.156151	60	1146.28	3.059290	60	955.37	2.980170

	dius R.	R.	Deg. D.	Radius R.	Log. R.			
9° 0′	637.27	2.804327	11° 0′	521.67	2.717397	13° 0′	441.68	2.645111
2	634.93	.802724	2	520.10	.716087	2	440.56	004
4	632.60	.801128	4	518.54	.714781	4	439.44	899
6	630.29	.799538	6	516.99	.713479	6	438.33	798
8	627.99	.797953	8	515.44	.712181	8	437.22	699
10	625.71	2.796374	10	513.91	2.710887	10	436.12	2 603
12	623.45	.794801	12	512.38	.709596	12	435.02	510
14	621.20	.793234	14	510.87	.708310	14	433.93	419
16	618.97	.791673	16	509.36	.707027	16	432.84	331
18	616.76	.790117	18	507.86	.705748	18	431.76	246
20	614.56	2.788566	20	506.38	2.704473	20	430.69	2 164
22	612.38	.787021	22	504.90	.703202	22	429.62	085
24	610.21	.785482	24	503.42	.701934	24	428.56	008
26	608.06	.783948	26	501.96	.700671	26	427.50	934
28	605.93	.782420	28	500.51	.699410	28	426.44	863
30	603.80	2.780897	30	499.06	2.698154	30	425.40	2 794
32	601.70	.779379	32	497.62	.696901	32	424.35	728
34	599.61	.777867	34	496.19	.695652	34	423.32	565
36	597.53	.776360	36	494.77	.694407	36	422.28	504
38	595.47	.774858	38	493.36	.693165	38	421.26	.546
40	42	2.	40	491.96	2. 26	40	420.23	2.623490
42	38	.	42	490.56	. 92	42	419.22	.622437
44	36	.	44	489.17	. 60	44	418.20	.621387
46	36	.	46	487.79	. 33	46	417.19	.620339
48	36	.	48	486.42	. 08	48	416.19	.619294
50	38	2.	50	485.05	2. 88	50	415.19	2.618251
52	42	.	52	483.69	. 70	52	414.20	.617211
54	46	.	54	482.34	.683357	54	413.21	.616173
56	53	.	56	481.00	.682146	56	412.23	.615138
58	60	.	58	479.67	.680939	58	411.25	.614106
10° 0′	573.69	2.758674	12° 0′	478.34	2.679735	14° 0′	410.28	2.613076
2	571.78	.757232	2	477.02	.678535	2	409.31	.612048
4	569.90	.755796	4	475.71	.677338	4	408.34	.611023
6	568.02	.754364	6	474.40	.676145	6	407.38	.610000
8	566.16	.752937	8	473.10	.674954	8	406.42	.608980
10	564.31	2.751514	10	471.81	2.673767	10	405.47	2.607962
12	562.47	.750096	12	470.53	.672584	12	404.53	.606946
14	560.64	.748683	14	469.25	.671403	14	403.58	.605933
16	558.82	.747274	16	467.98	.670226	16	402.65	.604923
18	557.02	.745870	18	466.72	.669052	18	401.71	.603914
20	555.23	2.744471	20	465.46	2.667881	20	400.78	2.602908
22	553.45	.743076	22	464.21	.666713	22	399.86	.601905
24	551.68	.741686	24	462.96	.665549	24	398.94	.600904
26	549.92	.740300	26	461.73	.664388	26	398.02	.599905
28	548.17	.738918	28	460.50	.663229	28	397.11	.598908
30	546.44	2.737541	30	459.28	2.662074	30	396.20	2.597914
32	544.71	.736169	32	458.06	.660922	32	395.30	.596922
34	543.00	.734800	34	456.85	.659773	34	394.40	.595933
36	541.30	.733436	36	455.65	.658628	36	393.50	.594945
38	539.61	.732077	38	454.45	.657485	38	392.61	.593960
40	537.92	2.730721	40	453.26	2.656345	40	391.72	2.592978
42	536.25	.729370	42	452.07	.655208	42	390.84	.591997
44	534.59	.728023	44	450.89	.654075	44	389.96	.591019
46	532.94	.726681	46	449.72	.652944	46	389.08	.590043
48	531.30	.725342	48	448.56	.651816	48	388.21	.589069
50	529.67	2.724008	50	447.40	2.650691	50	387.34	2.588097
52	528.05	.722677	52	446.24	.649570	52	386.48	.587128
54	526.44	.721351	54	445.09	.648451	54	385.62	.586161
56	524.84	.720029	56	443.95	.647335	56	384.77	.585196
58	523.25	.718711	58	442.81	.646221	58	383.91	.584233
60	521.67	2.717397	60	441.68	2.645111	60	383.06	2.583272

Deg. D.	Radius R.	Log. R.	Deg. D.	Radius R.	Log. R.	Deg. D.	Radius R.	Log. R.
15° 0'	383.06	2.583272	20° 0'	287.94	2.459300	30° 0'	193.19	2.285974
5	380.96	580880	10	285.58	455733	10	192.14	283623
10	378.88	578501	20	283.27	452195	20	191.11	281286
15	376.82	576135	30	280.99	448688	30	190.09	278963
20	374.79	573783	40	278.75	445209	40	189.08	276652
25	372.77	571443	50	276.54	441759	50	188.09	274355
30	370.78	2.569116	21° 0'	274.37	2.438337	31° 0'	187.10	2.272071
35	368.81	566802	10	272.23	434943	10	186.12	269800
40	366.86	564500	20	270.13	431575	20	185.16	267541
45	364.93	562210	30	268.06	428235	30	184.20	265295
50	363.02	559933	40	266.02	424921	40	183.26	263062
55	361.13	557668	50	264.02	421633	50	182.32	260841
16° 0'	359.26	2.555415	22° 0'	262.04	2.418371	32° 0'	181.40	2.258632
5	357.42	553173	10	260.10	415134	10	180.48	256435
10	355.59	550944	20	258.18	411922	20	179.58	254250
15	353.77	548726	30	256.29	408734	30	178.68	252077
20	351.98	546519	40	254.43	405571	40	177.79	249916
25	350.21	544324	50	252.60	402431	50	176.92	247766
30	348.45	2.542140	23° 0'	250.79	2.399315	33° 0'	176.05	2.245628
35	346.71	539968	10	249.01	396222	10	175.19	243501
40	344.99	537806	20	247.26	393151	20	174.34	241386
45	343.29	535655	30	245.53	390103	30	173.49	239282
50	341.60	533516	40	243.82	387077	40	172.66	237188
55	339.93	531386	50	242.14	384073	50	171.83	235106
17° 0'	338.27	2.529268	24° 0	240.49	2.381091	34° 0'	171.02	2.233035
5	336.64	527160	10	238.85	378130	10	170.21	230974
10	335.01	525062	20	237.24	375190	20	169.40	228924
15	333.41	522975	30	235.65	372270	30	168.61	226884
20	331.82	520898	40	234.08	369371	40	167.82	224855
25	330.24	518831	50	232.54	366492	50	167.05	222837
30	328.68	2.516774	25° 0'	231.01	2.363633	35° 0'	166.28	2.220828
35	327.13	514727	10	229.51	360794	10	165.51	218830
40	325.60	512690	20	228.02	357974	20	164.76	216842
45	324.09	510662	30	226.55	355173	30	164.01	214863
50	322.59	508645	40	225.11	352391	40	163.27	212895
55	321.10	506636	50	223.68	349627	50	162.53	210937
18° 0'	319.62	2.504638	26° 0'	222.27	2.346882	36° 0'	161.80	2.208988
5	318.16	502648	10	220.88	344155	10	161.08	207048
10	316.71	500668	20	219.51	341446	20	160.37	205119
15	315.28	498697	30	218.15	338755	30	159.66	203198
20	313.86	496736	40	216.81	336081	40	158.96	201288
25	312.45	494783	50	215.49	333424	50	158.27	199386
30	311.06	2.492839	27° 0'	214.18	2.330785	37° 0'	157.58	2.197494
35	309.67	490904	10	212.89	328162	10	156.90	195610
40	308.30	488978	20	211.62	325556	20	156.22	193736
45	306.95	487061	30	210.36	322967	30	155.55	191871
50	305.60	485152	40	209.12	320393	40	154.89	190014
55	304.27	483252	50	207.89	317836	50	154.23	188167
19° 0'	302.94	2.481361	28° 0'	206.68	2.315295	38° 0'	153.58	2.186328
5	301.63	479478	10	205.48	312769	10	152.93	184498
10	300.33	477603	20	204.30	310259	20	152.29	182676
15	299.04	475736	30	203.13	307764	30	151.66	180863
20	297.77	473878	40	201.97	305285	40	151.03	179059
25	296.50	472028	50	200.83	302820	50	150.41	177263
30	295 25	2.470186	29° 0'	199.70	2.300370	39° 0'	149.79	2.175475
35	294.00	468352	10	198.58	297935	10	149.17	173695
40	292.77	466526	20	197.48	295515	20	148.57	171924
45	291.55	464708	30	196.38	293108	30	147.97	170160
50	290.33	462897	40	195.31	290716	40	147.37	168405
55	289.13	461095	50	194.24	288338	50	146.78	166658
60	287.94	2.459300	60	193.19	2.285974	60	146.19	2.164918

TABLE II—TANGENT OFFSETS AND MIDDLE ORDINATES.

Deg.	Tang. Offs.	Mid. Ord.	Deg.	Tang. Offs.	Mid. Ord.	Deg.	Tang. Offs.	Mid. Ord.
0° 0'	.000	.000	2° 0'	1.745	.436	4° 0'	3.490	.873
2	.029	.007	2	.774	.444	2	.519	.880
4	.058	.015	4	.803	.451	4	.548	.887
6	.087	.022	6	.832	.458	6	.577	.895
8	.116	.029	8	.862	.465	8	.606	.902
10	.145	.036	10	1.891	.473	10	3.635	.909
12	.175	.044	12	.920	.480	12	.664	.916
14	.204	.051	14	.949	.487	14	.693	.924
16	.233	.058	16	.978	.495	16	.723	.931
18	.262	.065	18	2.007	.502	18	.752	.938
20	.291	.073	20	2.036	.509	20	3.781	.945
22	.320	.080	22	.065	.516	22	.810	.953
24	.349	.087	24	.094	.524	24	.839	.960
26	.378	.095	26	.123	.531	26	.868	.967
28	.407	.102	28	.152	.538	28	.897	.975
30	.436	.109	30	2.181	.545	30	3.926	.982
32	.465	.116	32	.211	.553	32	.955	.989
34	.495	.124	34	.240	.560	34	.984	.996
36	.524	.131	36	.269	.567	36	4.013	1.004
38	.553	.138	38	.298	.575	38	.042	.011
40	.582	.145	40	2.327	.582	40	4.071	1.018
42	.611	.153	42	.356	.589	42	.100	.026
44	.640	.160	44	.385	.596	44	.129	.033
46	.669	.167	46	.414	.604	46	.159	.040
48	.698	.175	48	.443	.611	48	.188	.047
50	.727	.182	50	2.472	.618	50	4.217	1.055
52	.756	.189	52	.501	.625	52	.246	.062
54	.785	.196	54	.530	.633	54	.275	.069
56	.814	.204	56	.560	.640	56	.304	.076
58	.844	.211	58	.589	.647	58	.333	.084
1° 0'	.873	.218	3° 0'	2.618	.655	5° 0'	4.362	1.091
2	.902	.225	2	.647	.662	2	.391	.098
4	.931	.233	4	.676	.669	4	.420	.106
6	.960	.240	6	.705	.676	6	.449	.113
8	.989	.247	8	.734	.684	8	.478	.120
10	1.018	.255	10	2.763	.691	10	4.507	1.127
12	.047	.262	12	.792	.698	12	.536	.135
14	.076	.269	14	.821	.705	14	.565	.142
16	.105	.276	16	.850	.713	16	.594	.149
18	.134	.284	18	.879	.720	18	.623	.156
20	1.164	.291	20	2.908	.727	20	4.653	1.164
22	.193	.298	22	.938	.735	22	.682	.171
24	.222	.305	24	.967	.742	24	.711	.178
26	.251	.313	26	.996	.749	26	.740	.186
28	.280	.320	28	3.025	.756	28	.769	.193
30	1.309	.327	30	3.054	.764	30	4.798	1.200
32	.338	.335	32	.083	.771	32	.827	.207
34	.367	.342	34	.112	.778	34	.856	.215
36	.396	.349	36	.141	.785	36	.885	.222
38	.425	.356	38	.170	.793	38	.914	.229
40	1.454	.364	40	3.199	.800	40	4.943	1.237
42	.483	.371	42	.228	.807	42	.972	.244
44	.513	.378	44	.257	.815	44	5.001	.251
46	.542	.385	46	.286	.822	46	.030	.258
48	.571	.393	48	.316	.829	48	.059	.266
50	1.600	.400	50	3.345	.836	50	5.088	1.273
52	.629	.407	52	.374	.844	52	.117	.280
54	.658	.415	54	.403	.851	54	.146	.287
56	.687	.422	56	.432	.858	56	.175	.295
58	.716	.429	58	.461	.865	58	.205	.302

TABLE II.—TANGENT OFFSETS AND MIDDLE ORDINATES.

Deg.	Tang. Offs.	Mid. Ord.	Deg.	Tang. Offs.	Mid. Ord.	Deg.	Tang. Offs.	Mid. Ord.
6° 0'	5.234	1.309	16° 0'	13.917	3.496	26° 0'	22.495	5.697
10	.379	.346	10	14.061	.533	10	.637	.734
20	.524	.382	20	.205	.569	20	.778	.770
30	.669	.418	30	.349	.606	30	.920	.807
40	.814	.455	40	.493	.643	40	23.062	.844
50	.960	.491	50	.637	.679	50	.203	.881
7° 0'	6.105	1.528	17° 0'	14.781	3.716	27° 0'	23.345	5.918
10	.250	.564	10	.925	.752	10	.486	.955
20	.395	.600	20	15.069	.789	20	.627	.992
30	.540	.637	30	.212	.825	30	.769	6.029
40	.685	.673	40	.356	.862	40	.910	.065
50	.831	.710	50	.500	.899	50	24.051	.102
8° 0'	6.976	1.746	18° 0'	15.643	3.935	28° 0'	24.192	6.139
10	7.121	.782	10	.787	.972	10	.333	.176
20	.266	.819	20	.931	4.008	20	.474	.213
30	.411	.855	30	16.074	.045	30	.615	.250
40	.556	.892	40	.218	.081	40	.756	.287
50	.701	.928	50	.361	.118	50	.897	.324
9° 0'	7.846	1.965	19° 0'	16.505	4.155	29° 0'	25.038	6.361
10	.991	2.001	10	.648	.191	10	.179	.398
20	8.136	.037	20	.792	.228	20	.320	.435
30	.281	.074	30	.935	.265	30	.460	.472
40	.426	.110	40	17.078	.301	40	.601	.509
50	.571	.147	50	.222	.338	50	.741	.546
10° 0'	8.716	2.183	20° 0'	17.365	4.374	30° 0'	25.882	6.583
10	.860	.219	10	.508	.411	10	26.022	.620
20	9.005	.256	20	.651	.448	20	.163	.657
30	.150	.292	30	.794	.484	30	.303	.694
40	.295	.329	40	.937	.521	40	.443	.731
50	.440	.365	50	18.081	.558	50	.584	.768
11° 0'	9.585	2.402	21° 0'	18.224	4.594	31° 0'	26.724	6.805
10	.729	.438	10	.367	.631	20	27.004	.879
20	.874	.475	20	.509	.668	40	.284	.953
30	10.019	.511	30	.652	.704	32° 0'	.564	7.027
40	.164	.547	40	.795	.741	20	.843	.101
50	.308	.584	50	.938	.778	40	28.123	.175
12° 0'	10.453	2.620	22° 0'	19.081	4.814	33° 0'	28.402	7.250
10	.597	.657	10	.224	.851	20	.680	.324
20	.742	.693	20	.366	.888	40	.959	.398
30	.887	.730	30	.509	.925	34° 0'	29.237	.473
40	11.031	.766	40	.652	.961	20	.515	.547
50	.176	.803	50	.794	.998	40	.793	.621
13° 0'	11.320	2.839	23° 0'	19.937	5.035	35° 0'	30.071	7.696
10	.465	.876	10	20.079	.071	20	.348	.770
20	.609	.912	20	.222	.108	40	.625	.845
30	.754	.949	30	.364	.145	36° 0'	.902	.919
40	.898	.985	40	.507	.182	20	31.178	.994
50	12.043	3.022	50	.649	.218	40	.454	8.068
14° 0'	12.187	3.058	24° 0'	20.791	5.255	37° 0'	31.730	8.143
10	.331	.095	10	.933	.292	20	32.006	.218
20	.476	.131	20	21.076	.329	40	.282	.292
30	.620	.168	30	.218	.366	38° 0'	.557	.367
40	.764	.204	40	.360	.402	20	.832	.442
50	.908	.241	50	.502	.439	40	33.106	.517
15° 0'	13.053	3.277	25° 0'	21.644	5.476	39° 0'	33.381	8.592
10	.197	.314	10	.786	.513	20	.655	.667
20	.341	.350	20	.928	.549	40	.929	.741
30	.485	.387	30	22.070	.586	40° 0'	34.202	.816
40	.629	.423	40	.212	.623	20	.475	.891
50	.773	.460	50	.353	.660	40	.748	.966
60	13.917	3.496	60	22.495	5.697	41° 0'	35.021	9.041

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M	0°	1°	2°	3°	4°	5°	6°			9°	M
0	0.0	50.0	100.0	150.0	200.1	250.2	300.3	350.4	400.7	450.9	0
1	0.8	50.8	00.8	50.9	00.9	51.0	01.1	51.3	01.5	51.8	1
2	1.7	51.7	01.7	51.7	01.8	51.8	01.9	52.1	02.3	52.6	2
3	2.5	52.5	02.5	52.5	02.6	52.7	02.8	52.9	03.2	53.4	3
4	3.3	53.3	03.3	53.4	03.4	53.5	03.6	53.8	04.0	54.3	4
5	4.2	54.2	104.2	154.2	204.3	254.3	304.5	354.6	404.8	455.1	5
6	5.0	55.0	05.0	55.0	05.1	55.2	05.3	55.5	05.7	56.0	6
7	5.8	55.8	05.8	55.9	05.9	56.0	06.1	56.3	06.5	56.8	7
8	6.7	56.7	06.7	56.7	06.8	56.8	07.0	57.1	07.4	57.6	8
9	7.5	57.5	07.5	57.5	07.6	57.7	07.8	58.0	08.2	58.5	9
10	8.3	58.3	108.3	158.4	208.4	258.5	308.6	358.8	409.0	459.3	10
11	9.2	59.2	09.2	59.2	09.3	59.3	09.5	59.6	09.9	60.2	11
12	10.0	60.0	10.0	60.0	10.1	60.2	10.3	60.5	10.7	61.0	12
13	10.8	60.8	10.8	60.9	10.9	61.0	11.1	61.3	11.5	61.8	13
14	11.7	61.7	11.7	61.7	11.8	61.9	12.0	62.2	12.4	62.7	14
15	12.5	62.5	112.5	162.5	212.6	262.7	312.8	363.0	413.2	463.5	15
16	13.3	63.3	13.3	63.4	13.4	63.5	13.7	63.8	14.1	64.4	16
17	14.2	64.2	14.2	64.2	14.3	64.4	14.5	64.7	14.9	65.2	17
18	15.0	65.0	15.0	65.0	15.1	65.2	15.3	65.5	15.7	66.0	18
19	15.8	65.8	15.9	65.9	15.9	66.0	16.2	66.3	16.6	66.9	19
20	16.7	66.7	116.7	166.7	216.8	266.9	317.0	367.2	417.4	467.7	20
21	17.5	67.5	17.5	67.6	17.6	67.7	17.8	68.0	18.2	68.5	21
22	18.3	68.3	18.4	68.4	18.4	68.5	18.7	68.8	19.1	69.4	22
23	19.2	69.2	19.2	69.2	19.3	69.4	19.5	69.7	19.9	70.2	23
24	20.0	70.0	20.0	70.1	20.1	70.2	20.3	70.5	20.8	71.1	24
25	20.8	70.8	120.9	170.9	220.9	271.0	321.2	371.4	421.6	471.9	25
26	21.7	71.7	21.7	71.7	21.8	71.9	22.0	72.2	22.4	72.7	26
27	22.5	72.5	22.5	72.6	22.6	72.7	22.8	73.0	23.3	73.6	27
28	23.3	73.3	23.4	73.4	23.4	73.5	23.7	73.9	24.1	74.4	28
29	24.2	74.2	24.2	74.2	24.3	74.4	24.5	74.7	24.9	75.3	29
30	25.0	75.0	125.0	175.1	225.1	275.2	325.4	375.5	425.8	476.1	30
31	25.8	75.8	25.9	75.9	26.0	76.1	26.2	76.4	26.6	76.9	31
32	26.7	76.7	26.7	76.7	26.8	76.9	27.0	77.2	27.5	77.8	32
33	27.5	77.5	27.5	77.6	27.6	77.7	27.9	78.1	28.3	78.6	33
34	28.3	78.3	28.4	78.4	28.5	78.6	28.7	78.9	29.1	79.5	34
35	29.2	79.2	129.2	179.2	229.3	279.4	329.5	379.7	430.0	480.3	35
36	30.0	80.0	30.0	80.1	30.1	80.2	30.4	80.6	30.8	81.1	36
37	30.8	80.8	30.9	80.9	31.0	81.1	31.2	81.4	31.7	82.0	37
38	31.7	81.7	31.7	81.7	31.8	81.9	32.0	82.2	32.5	82.8	38
39	32.5	82.5	32.5	82.6	32.6	82.7	32.9	83.1	33.3	83.6	39
40	33.3	83.3	133.4	183.4	233.5	283.6	333.7	383.9	434.2	484.5	40
41	34.2	84.2	34.2	84.2	34.3	84.4	34.6	84.7	35.0	85.3	41
42	35.0	85.0	35.0	85.1	35.1	85.2	35.4	85.6	35.8	86.2	42
43	35.8	85.8	35.9	85.9	36.0	86.1	36.2	86.4	36.7	87.0	43
44	36.7	86.7	36.7	86.7	36.8	86.9	37.1	87.3	37.5	87.8	44
45	37.5	87.5	137.5	187.6	237.6	287.7	337.9	388.1	438.4	488.7	45
46	38.3	88.3	38.4	88.4	38.5	88.6	38.7	88.9	39.2	89.5	46
47	39.2	89.2	39.2	89.2	39.3	89.4	39.6	89.8	40.0	90.4	47
48	40.0	90.0	40.0	90.1	40.1	90.3	40.4	90.6	40.9	91.2	48
49	40.8	90.8	40.9	90.9	41.0	91.1	41.2	91.4	41.7	92.0	49
50	41.7	91.7	141.7	191.7	241.8	291.9	342.1	392.3	442.5	492.9	50
51	42.5	92.5	42.5	92.6	42.6	92.8	42.9	93.1	43.4	93.7	51
52	43.3	93.3	43.4	93.4	43.5	93.6	43.7	94.0	44.2	94.6	52
53	44.2	94.2	44.2	94.2	44.3	94.4	44.6	94.8	45.1	95.4	53
54	45.0	95.0	45.0	95.1	45.2	95.3	45.4	95.6	45.9	96.2	54
55	45.8	95.8	145.9	195.9	246.0	296.1	346.3	396.5	446.7	497.1	55
56	46.7	96.7	46.7	96.7	46.8	96.9	47.1	97.3	47.6	97.9	56
57	47.5	97.5	47.5	97.6	47.7	97.8	47.9	98.1	48.4	98.8	57
58	48.3	98.3	48.4	98.4	48.5	98.6	48.8	99.0	49.3	99.6	58
59	49.2	99.2	49.2	99.2	49.3	99.4	49.6	99.8	50.1	500.4	59
60	50.0	100.0	150.0	200.1	250.2	300.3	350.4	400.7	450.9	501.3	60

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	19°	20°	21°	22°	23°	24°	25°	26°	M.
0	958.8	1010.3	1061.9	1113.7	1165.7	1217.9	1270.2	1322.8	0
1	59.7	11.2	62.8	14.6	66.6	18.7	71.1	23.7	1
2	60.5	12.0	63.7	15.5	67.4	19.6	72.0	24.5	2
3	61.4	12.9	64.5	16.3	68.3	20.5	72.9	25.4	3
4	62.2	13.7	65.4	17.2	69.2	21.4	73.7	26.3	4
5	963.1	1014.6	1066.2	1118.1	1170.1	1222.2	1274.6	1327.2	5
6	64.0	15.4	67.1	18.9	70.9	23.1	75.5	28.1	6
7	64.8	16.3	68.0	19.8	71.8	24.0	76.4	28.9	7
8	65.7	17.2	68.8	20.7	72.7	24.8	77.2	29.8	8
[illegible]	66.5	18.0	69.7	21.5	73.5	25.7	78.1	30.7	9
10	967.4	1018.9	1070.6	1122.4	1174.4	1226.6	1279.0	1331.6	10
11	68.2	19.8	71.4	23.2	75.3	27.5	79.9	32.5	11
12	69.1	20.6	72.3	24.1	76.1	28.3	80.7	33.3	12
13	70.0	21.5	73.1	25.0	77.0	29.2	81.6	34.2	13
14	70.8	22.3	74.0	25.8	77.9	30.1	82.5	35.1	14
15	971.7	1023.2	1074.9	1126.7	1178.7	1230.9	1283.4	1336.0	15
16	72.5	24.0	75.7	27.6	79.6	31.8	84.2	36.8	16
17	73.4	24.9	76.6	28.4	80.5	32.7	85.1	37.7	17
18	74.2	25.8	77.5	29.3	81.3	33.6	86.0	38.6	18
19	75.1	26.6	78.3	30.2	82.2	34.4	86.9	39.5	19
20	976.0	1027.5	1079.2	1131.0	1183.1	1235.3	1287.7	1340.4	20
21	76.8	28.3	80.0	31.9	83.9	36.2	88.6	41.2	21
22	77.7	29.2	80.9	32.8	84.8	37.0	89.5	42.1	22
23	78.5	30.1	81.8	33.6	85.7	37.9	90.4	43.0	23
24	79.4	30.9	82.6	34.5	86.6	38.8	91.2	43.9	24
25	980.2	1031.8	1083.5	1135.4	1187.4	1239.7	1292.1	1344.8	25
26	81.1	32.6	84.4	36.2	88.3	40.5	93.0	45.6	26
27	82.0	33.5	85.2	37.1	89.2	41.4	93.9	46.5	27
28	82.8	34.4	86.1	38.0	90.0	42.4	94.7	47.4	28
29	83.7	35.2	86.9	38.8	90.9	43.2	95.6	48.3	29
30	984.5	1036.1	1087.8	1139.7	1191.8	1244.0	1296.5	1349.2	30
31	85.4	37.0	88.7	40.6	92.6	44.9	97.4	50.0	31
32	86.3	37.8	89.5	41.4	93.5	45.8	98.2	50.9	32
33	87.1	38.7	90.4	42.3	94.4	46.6	99.1	51.8	33
34	88.0	39.5	91.3	43.2	95.2	47.5	1300.0	52.7	34
35	988.8	1040.4	1092.1	1144.0	1196.1	1248.4	1300.9	1353.6	35
36	89.7	41.3	93.0	44.9	97.0	49.3	01.7	54.4	36
37	90.5	42.1	93.9	45.8	97.9	50.1	02.6	55.3	37
38	91.4	43.0	94.7	46.6	98.7	51.0	03.5	56.2	38
39	92.3	43.8	95.6	47.5	99.6	51.9	04.4	57.1	39
40	993.1	1044.7	1096.4	1148.4	1200.5	1252.8	1305.3	1358.0	40
41	94.0	45.6	97.3	49.2	01.3	53.6	06.1	58.8	41
42	94.8	46.4	98.2	50.1	02.2	54.5	07.0	59.7	42
43	95.7	47.3	99.0	51.0	03.1	55.4	07.9	60.6	[illegible]
44	96.5	48.1	99.9	51.8	03.9	56.3	08.8	61.5	44
45	997.4	1049.0	1100.8	1152.7	1204.8	1257.1	1309.6	1362.4	45
46	98.3	49.9	01.6	53.6	05.7	58.0	10.5	63.2	46
47	99.1	50.7	02.5	54.4	06.6	58.9	11.4	64.1	47
48	1000.0	51.6	03.4	55.3	07.4	59.7	12.3	65.0	48
49	00.8	52.4	04.2	56.2	08.3	60.6	13.1	65.9	49
50	1001.7	1053.3	1105.1	1157.0	1209.2	1261.5	1314.0	1366.8	50
51	02.6	54.2	05.9	57.9	10.0	62.4	14.9	67.6	51
52	03.4	55.0	06.8	58.8	10.9	63.2	15.8	68.5	52
53	04.3	55.9	07.7	59.6	11.8	64.1	16.7	69.4	53
54	05.1	56.8	08.5	60.5	12.7	65.0	17.5	70.3	54
55	1006.0	1057.6	1109.4	1161.4	1213.5	1265.9	1318.4	1371.2	55
56	06.9	58.5	10.3	62.2	14.4	66.7	19.3	72.0	56
57	07.7	59.3	11.1	63.1	15.3	67.6	20.2	72.9	57
58	08.6	60.2	12.0	64.0	16.1	68.5	21.0	73.8	58
59	09.4	61.1	12.9	64.8	17.0	69.4	21.9	74.7	59
60	1010.3	1061.9	1113.7	1165.7	1217.9	1270.2	1322.8	1375.6	60
	19°	20°	21°	22°	23°	24°			

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	35°	36°	37°	38°	39°	40°	41°	42°	M.
0	1806.6	1861.7	1917.1	1972.9	2029.0	2085.4	2142.2	2199.4	0
1	07.5	62.6	18.0	73.8	29.9	86.4	43.2	2200.4	1
2	08.4	63.5	19.0	74.7	30.9	87.3	44.1	01.3	2
3	09.3	64.4	19.9	75.7	31.8	88.3	45.1	02.3	3
4	10.2	65.4	20.8	76.6	32.7	89.2	46.0	03.2	4
5	1811.1	1866.3	1921.7	1977.5	2033.7	2090.1	2147.0	2204.2	5
6	12.1	67.2	22.7	78.5	34.6	91.1	47.9	05.1	6
7	13.0	68.1	23.6	79.4	35.5	92.0	48.9	06.1	7
8	13.9	69.0	24.5	80.3	36.5	93.0	49.8	07.1	8
9	14.8	70.0	25.5	81.3	37.4	93.9	50.8	08.0	9
10	1815.7	1870.9	1926.4	1982.2	2038.4	2094.9	2151.7	2209.0	10
11	16.6	71.8	27.3	83.1	39.3	95.8	52.7	09.9	11
12	17.6	72.7	28.2	84.1	40.2	96.8	53.6	10.9	12
13	18.5	73.7	29.2	85.0	41.2	97.7	54.6	11.8	13
14	19.4	74.6	30.1	85.9	42.1	98.6	55.5	12.8	14
15	1820.3	1875.5	1931.0	1986.9	2043.1	2099.6	2156.5	2213.8	15
16	21.2	76.4	32.0	87.8	44.0	2100.5	57.4	14.7	16
17	22.1	77.4	32.9	88.7	44.9	01.5	58.4	15.7	17
18	23.1	78.3	33.8	89.7	45.9	02.4	59.3	16.6	18
19	24.0	79.2	34.7	90.6	46.8	03.4	60.3	17.6	19
20	1824.9	1880.1	1935.7	1991.5	2047.8	2104.3	2161.2	2218.6	20
21	25.8	81.0	36.6	92.5	48.7	05.3	62.2	19.5	21
22	26.7	82.0	37.5	93.4	49.6	06.2	63.2	20.5	22
23	27.6	82.9	38.5	94.3	50.6	07.2	64.1	21.4	23
24	28.6	83.8	39.4	95.3	51.5	08.1	65.1	22.4	24
25	1829.5	1884.7	1940.3	1996.2	2052.5	2109.0	2166.0	2223.3	25
26	30.4	85.7	41.2	97.1	53.4	10.0	67.0	24.3	26
27	31.3	86.6	42.2	98.1	54.3	10.9	67.9	25.3	27
28	32.2	87.5	43.1	99.0	55.3	11.9	68.9	26.2	28
29	33.2	88.4	44.0	99.9	56.2	12.8	69.8	27.2	29
30	1834.1	1889.4	1945.0	2000.9	2057.2	2113.8	2170.8	2228.1	30
31	35.0	90.3	45.9	01.8	58.1	14.7	71.7	29.1	31
32	35.9	91.2	46.8	02.8	59.0	15.7	72.7	30.1	32
33	36.8	92.1	47.7	03.7	60.0	16.6	73.6	31.0	33
34	37.8	93.1	48.7	04.6	60.9	17.6	74.6	32.0	34
35	1838.7	1894.0	1949.6	2005.6	2061.9	2118.5	2175.5	2232.9	35
36	39.6	94.9	50.5	06.5	62.8	19.5	76.5	33.9	36
37	40.5	95.8	51.5	07.4	63.7	20.4	77.4	34.9	37
38	41.4	96.7	52.4	08.4	64.7	21.4	78.4	35.8	38
39	42.4	97.7	53.3	09.3	65.6	22.3	79.4	36.8	39
40	1843.3	1898.6	1954.3	2010.2	2066.6	2123.3	2180.3	2237.7	40
41	44.2	99.5	55.2	11.2	67.5	24.2	81.3	38.7	41
42	45.1	1900.4	56.1	12.1	68.5	25.1	82.2	39.7	42
43	46.0	01.4	57.0	13.0	69.4	26.1	83.2	40.6	43
44	47.0	02.3	58.0	14.0	70.3	27.0	84.1	41.6	44
45	1847.9	1903.2	1958.9	2014.9	2071.3	2128.0	2185.1	2242.5	45
46	48.8	04.2	59.8	15.9	72.2	28.9	86.0	43.5	46
47	49.7	05.1	60.8	16.8	73.2	29.9	87.0	44.5	47
48	50.6	06.0	61.7	17.7	74.1	30.8	87.9	45.4	48
49	51.5	06.9	62.6	18.7	75.0	31.8	88.9	46.4	49
50	1852.5	1907.9	1963.6	2019.6	2076.0	2132.7	2189.9	2247.3	50
51	53.4	08.8	64.5	20.5	76.9	33.7	90.8	48.3	51
52	54.3	09.7	65.4	21.5	77.9	34.6	91.8	49.3	52
53	55.2	10.6	66.4	22.4	78.8	35.6	92.7	50.2	53
54	56.2	11.6	67.3	23.4	79.8	36.5	93.7	51.2	54
55	1857.1	1912.5	1968.2	2024.3	2080.7	2137.5	2194.6	2252.2	55
56	58.0	13.4	69.1	25.2	81.6	38.4	95.6	53.1	56
57	58.9	14.3	70.1	26.2	82.6	39.4	96.5	54.1	57
58	59.8	15.3	71.0	27.1	83.5	40.3	97.5	55.0	58
59	60.8	16.2	71.9	28.0	84.5	41.3	98.5	56.0	59
60	1861.7	1917.1	1972.9	2029.0	2085.4	2142.2	2199.4	2257.0	60
	35°	36°	37°	38°	39°	40°	41°	42°	

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

			53°					58°	M.
0	2732.9	2794.5	2856.7	2919.4	2982.7	3046.5	3110.9	3176.0	
1	33.9	95.6	57.7	20.5	83.7	47.6	12.0	77.1	
2	34.9	96.6	58.8	21.5	84.8	48.6	13.1	78.2	
3	36.0	97.6	59.8	22.6	85.8	49.7	14.2	79.3	
4	37.0	98.7	60.9	23.6	86.9	50.8	15.3	80.4	
5	2738.0	2799.7	2861.9	2924.7	2988.0	3051.9	3116.3	3181.4	
6	39.0	2800.7	62.9	25.7	89.0	52.9	17.4	82.5	
7	40.1	01.8	64.0	26.8	90.1	54.0	18.5	83.6	
8	41.1	02.8	65.0	27.8	91.1	55.1	19.6	84.7	
9	42.1	03.8	66.1	28.9	92.2	56.1	20.7	85.8	
10	2743.1	2804.9	2867.1	2929.9	2993.3	3057.2	3121.7	3186.9	
11	44.2	05.9	68.2	31.0	94.3	58.3	22.8	88.0	
12	45.2	06.9	69.2	32.0	95.4	59.3	23.9	89.1	
13	46.2	08.0	70.2	33.1	96.5	60.4	25.0	90.2	
14	47.2	09.0	71.3	34.1	97.5	61.5	26.1	91.3	
15	2748.3	2810.0	2872.3	2935.2	2998.6	3062.6	3127.2	3192.4	
16	49.3	11.1	73.4	36.2	99.6	63.6	28.2	93.5	
17	50.3	12.1	74.4	37.3	3000.7	64.7	29.3	94.5	
18	51.3	13.1	75.5	38.3	01.8	65.8	30.4	95.6	
19	52.4	14.2	76.5	39.4	02.8	66.8	31.5	96.7	
20	2753.4	2815.2	2877.5	2940.4	3003.9	3067.9	3132.6	3197.8	
21	54.4	16.2	78.6	41.5	04.9	69.0	33.6	98.9	
22	55.4	17.3	79.6	42.5	06.0	70.1	34.7	3200.0	
23	56.5	18.3	80.7	43.6	07.1	71.1	35.8	01.1	
24	57.5	19.3	81.7	44.6	08.1	72.2	36.9	02.2	
25	2758.5	2820.4	2882.8	2945.7	3009.2	3073.3	3138.0	3203.3	
26	59.5	21.4	83.8	46.7	10.3	74.4	39.1	04.4	
27	60.6	22.4	84.8	47.8	11.3	75.4	40.1	05.5	
28	61.6	23.5	85.9	48.9	12.4	76.5	41.2	06.6	28
29	62.6	24.5	86.9	49.9	13.5	77.6	42.3	07.7	29
30	2763.7	2825.6	2888.0	2951.0	3014.5	3078.7	3143.4	3208.8	30
31	64.7	26.6	89.0	52.0	15.6	79.7	44.5	09.9	31
32	65.7	27.6	90.1	53.1	16.6	80.8	45.6	10.9	32
33	66.7	28.7	91.1	54.1	17.7	81.9	46.6	12.0	
34	67.8	29.7	92.2	55.2	18.8	82.9	47.7	13.1	
35	2768.8	2830.7	2893.2	2956.2	3019.8	3084.0	3148.8	3214.2	
36	69.8	31.8	94.3	57.3	20.9	85.1	49.9	15.3	
37	70.8	32.8	95.3	58.3	22.0	86.2	51.0	16.4	
38	71.9	33.8	96.4	59.4	23.0	87.2	52.1	17.5	
39	72.9	34.9	97.4	60.5	24.1	88.3	53.2	18.6	
40	2773.9	2835.9	2898.4	2961.5	3025.2	3089.4	3154.2	3219.7	
41	75.0	37.0	99.5	62.6	26.2	90.5	55.3	20.8	
42	76.0	38.0	2900.5	63.6	27.3	91.6	56.4	21.9	
43	77.0	39.0	01.6	64.7	28.4	92.6	57.5	23.0	
44	78.1	40.1	02.6	65.7	29.4	93.7	58.6	24.1	
45	2779.1	2841.1	2903.7	2966.8	3030.5	3094.8	3159.7	3225.2	
46	80.1	42.1	04.7	67.9	31.6	95.9	60.8	26.3	46
47	81.1	43.2	05.8	68.9	32.6	96.9	61.8	27.4	47
48	82.2	44.2	06.8	70.0	33.7	98.0	62.9	28.5	48
49	83.2	45.3	07.9	71.0	34.8	[illegible]	[illegible]	[illegible]	
50	2784.2	2846.3	2908.9	2972.1	3035.8				
51	85.3	47.3	10.0	73.1	36.9				
52	86.3	48.4	11.0	74.2	38.0				
53	87.3	49.4	12.1	75.3	39.0				
54	88.4	50.5	13.1	76.3	40.1				
55	2789.4	2851.5	2914.2	2977.4	3041.2				
56	90.4	52.5	15.2	78.4	42.2				
57	91.4	53.6	16.3	79.5	43.3				
58	92.5	54.6	17.3	80.5	44.4				
59	93.5	55.7	18.4	81.6	45.4				
60	2794.5	2856.7	2919.4	2982.7	3046.5				

5°

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	59°	60°	61°	62°	63°	64°	65°	66°	M.
0	3241.7	3308.0	3375.0	3442.7	3511.1	3580.3	3650.2	3720.9	0
1	42.8	09.1	76.1	43.9	12.3	81.4	51.4	22.1	1
2	43.9	10.2	77.3	45.0	13.4	82.6	52.5	23.2	2
3	45.0	11.3	78.4	46.1	14.6	83.8	53.7	24.4	3
4	46.1	12.5	79.5	47.3	15.7	84.9	54.9	25.6	4
5	3247.2	3313.6	3380.6	3448.4	3516.9	3586.1	3656.1	3726.8	5
6	48.3	14.7	81.8	49.5	18.0	87.2	57.2	28.0	6
7	49.4	15.8	82.9	50.7	19.2	88.4	58.4	29.2	7
8	50.5	16.9	84.0	51.8	20.3	89.6	59.6	30.4	8
9	51.6	18.0	85.1	52.9	21.5	90.7	60.7	31.6	9
10	3252.7	3319.1	3386.3	3454.1	3522.6	3591.9	3661.9	3732.7	10
11	53.8	20.2	87.4	55.2	23.8	93.0	63.1	33.9	11
12	54.9	21.4	88.5	56.3	24.9	94.2	64.3	35.1	12
13	56.0	22.5	89.6	57.5	26.1	95.4	65.4	36.3	13
14	57.1	23.6	90.8	58.6	27.2	96.5	66.6	37.5	14
15	3258.2	3324.7	3391.9	3459.8	3528.4	3597.7	3667.8	3738.7	15
16	59.3	25.8	93.0	60.9	29.5	98.8	69.0	39.9	16
17	60.4	26.9	94.1	62.0	30.7	3600.0	70.1	41.1	17
18	61.5	28.0	95.3	63.2	31.8	01.2	71.3	42.2	18
19	62.6	29.2	96.4	64.3	33.0	02.3	72.5	43.4	19
20	3263.7	3330.3	3397.5	3465.[illegible]	3534.1	3603.5	3673.7	3744.6	20
21	64.8	31.4	98.6	66.[illegible]	35.3	04.7	74.8	45.8	21
22	65.9	32.5	99.8	67.7	36.4	05.8	76.0	47.0	22
23	67.0	33.6	3400.9	68.9	37.6	07.0	77.2	48.2	23
24	68.1	34.7	02.0	70.0	38.7	08.2	78.4	49.4	24
25	3269.2	3335.9	3403.1	3471.1	3539.9	3609.3	3679.5	3750.6	25
26	70.3	37.0	04.3	72.3	41.0	10.5	80.7	51.8	26
27	71.4	38.1	05.4	73.4	42.2	11.6	81.9	52.9	27
28	72.6	39.2	06.5	74.6	43.3	12.8	83.1	54.1	28
29	73.7	40.3	07.7	75.7	44.5	14.0	84.3	55.3	29
30	3274.8	3341.4	3408.8	3476.8	3545.6	3615.1	3685.4	3756.5	30
31	75.9	42.6	09.9	78.0	46.8	16.3	86.6	57.7	31
32	77.0	43.7	11.0	79.1	47.9	17.5	87.8	58.9	32
33	78.1	44.8	12.2	80.3	49.1	18.6	89.0	60.1	33
34	79.2	45.9	13.3	81.4	50.2	19.8	90.1	61.3	34
35	3280.3	3347.0	3414.4	3482.5	3551.4	3621.0	3691.3	3762.5	35
36	81.4	48.1	15.6	83.7	52.5	22.1	92.5	63.7	36
37	82.5	49.3	16.7	84.8	53.7	23.3	93.7	64.9	37
38	83.6	50.4	17.8	86.0	54.8	24.5	94.9	66.1	38
39	84.7	51.5	18.9	87.1	56.0	25.6	96.0	67.3	39
40	3285.8	3352.6	3420.1	3488.2	3557.2	3626.8	3697.2	3768.5	40
41	86.9	53.7	21.2	89.4	58.3	28.0	98.4	69.6	41
42	88.0	54.8	22.3	90.5	59.5	29.1	99.6	70.8	42
43	89.2	56.0	23.5	91.7	60.6	30.3	3700.8	72.0	43
44	90.3	57.1	24.6	92.8	61.8	31.5	02.0	73.2	44
45	3291.4	3358.2	3425.7	3494.0	3562.9	3632.6	3703.1	3774.4	45
46	92.5	59.3	26.9	95.1	64.1	33.8	04.3	75.6	46
47	93.6	60.4	28.0	96.2	65.2	35.0	05.5	76.8	47
48	94.7	61.6	29.1	97.4	66.4	36.1	06.7	78.0	48
49	95.8	62.7	30.3	98.5	67.5	37.3	07.9	79.2	49
50	3296.9	3363.8	3431.4	3499.7	3568.7	3638.5	3709.0	3780.[illegible]	50
51	98.0	64.9	32.5	3500.8	69.9	39.7	10.2	81.[illegible]	51
52	99.1	66.0	33.7	02.0	71.0	40.8	11.4	82.8	52
53	3300.2	67.2	34.8	03.1	72.2	42.0	12.6	84.0	53
54	01.4	68.3	35.9	04.3	73.3	43.2	13.8	85.2	54
55	3302.5	3369.4	3437.1	3505.4	3574.5	3644.3	3715.0	3786.4	55
56	03.6	70.5	38.2	06.6	75.6	45.5	16.1	87.6	56
57	04.7	71.7	39.3	07.7	76.8	46.7	17.3	88.8	57
58	05.8	72.8	40.5	08.8	78.0	47.8	18.5	90.0	58
59	06.9	73.9	41.6	10.0	79.1	49.0	19.7	91.2	59
60	3308.0	3375.0	3442.7	3511.1	3580.3	3650.2	3720.9	3792.4	60

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	67°	68°	69°	70°	71°	72°	73°	74°	M.
0	3792.4	3864.7	3937.9	4011.9	4086.9	4162.8	4239.7	4317.6	0
1	93.6	65.9	39.1	13.2	88.2	64.1	41.0	18.9	1
2	94.8	67.1	40.3	14.4	89.4	65.4	42.3	20.2	2
3	96.0	68.3	41.6	15.7	90.7	66.7	43.6	21.5	3
4	97.2	69.6	42.8	16.9	92.0	67.9	44.9	22.8	4
5	3798.4	3870.8	3944.0	4018.2	4093.2	4169.2	4246.2	4324.1	5
6	99.6	72.0	45.2	19.4	94.5	70.5	47.5	25.4	6
7	3800.8	73.2	46.5	20.6	95.7	71.8	48.8	26.8	7
8	02.0	74.4	47.7	21.9	97.0	73.0	50.0	28.1	8
9	03.2	75.6	48.9	23.1	98.2	74.3	51.3	29.4	9
10	3804.4	3876.8	3950.2	4024.4	4099.5	4175.6	4252.6	4330.7	10
11	05.6	78.0	51.4	25.6	4100.8	76.9	53.9	32.0	11
12	06.8	79.3	52.6	26.9	02.0	78.1	55.2	33.3	12
13	08.0	80.5	53.9	28.1	03.3	79.4	56.5	34.6	13
14	09.2	81.7	55.1	29.4	04.5	80.7	57.8	35.9	14
15	3810.4	3882.9	3956.3	4030.6	4105.8	4182.0	4259.1	4337.2	15
16	11.6	84.1	57.5	31.8	07.1	83.2	60.4	38.5	16
17	12.8	85.3	58.8	33.1	08.3	84.5	61.7	39.9	17
18	14.0	86.6	60.0	34.3	09.6	85.8	63.0	41.2	18
19	15.2	87.8	61.2	35.6	10.9	87.1	64.3	42.5	19
20	3816.4	3889.0	3962.5	4036.8	4112.1	4188.4	4265.6	4343.8	20
21	17.6	90.2	63.7	38.1	13.4	89.6	66.9	45.1	21
22	18.8	91.4	64.9	39.3	14.6	90.9	68.2	46.4	22
23	20.0	92.6	66.2	40.6	15.9	92.2	69.5	47.7	23
24	21.2	93.9	67.4	41.8	17.2	93.5	70.7	49.0	24
25	3822.4	3895.1	3968.6	4043.1	4118.4	4194.8	4272.0	4350.4	25
26	23.6	96.3	69.9	44.3	19.7	96.0	73.3	51.7	26
27	24.8	97.5	71.1	45.6	21.0	97.3	74.6	53.0	27
28	26.0	98.7	72.3	46.8	22.2	98.6	75.9	54.3	28
29	27.2	3900.0	73.6	48.1	23.5	99.9	77.2	55.6	29
30	3828.4	3901.2	3974.8	4049.3	4124.8	4201.2	4278.5	4356.9	30
31	29.6	02.4	76.0	50.6	26.0	02.4	79.8	58.2	31
32	30.8	03.6	77.3	51.8	27.3	03.7	81.1	59.6	32
33	32.0	04.8	78.5	53.1	28.6	05.0	82.4	60.9	33
34	33.3	06.1	79.7	54.3	29.8	06.3	83.7	62.2	34
35	3834.5	3907.3	3981.0	4055.6	4131.1	4207.6	4285.0	4363.5	35
36	35.7	08.5	82.2	56.8	32.4	08.8	86.3	64.8	36
37	36.9	09.7	83.4	58.1	33.6	10.1	87.6	66.1	37
38	38.1	10.9	84.7	59.3	34.9	11.4	88.9	67.5	38
39	39.3	12.2	85.9	60.6	36.2	12.7	90.2	68.8	39
40	3840.5	3913.4	3987.2	4061.8	4137.4	4214.0	4291.5	4370.1	40
41	41.7	14.6	88.4	63.1	38.7	15.3	92.8	71.4	41
42	42.9	15.8	89.6	64.3	40.0	16.5	94.1	72.7	[illegible]
43	44.1	17.1	90.9	65.6	41.2	17.8	95.4	74.1	43
44	45.3	18.3	92.1	66.8	42.5	19.1	96.7	75.4	44
45	3846.5	3919.5	3993.3	4068.1	4143.8	4220.4	4298.0	4376.7	45
46	47.7	20.7	94.6	69.3	45.0	21.7	99.3	78.0	46
47	49.0	21.9	95.8	70.6	46.3	23.0	4300.6	79.3	47
48	50.2	23.2	97.1	71.9	47.6	24.3	01.9	80.6	48
49	51.4	24.4	98.3	73.1	48.8	25.5	03.2	82.0	49
50	3852.6	3925.6	3999.5	4074.4	4150.1	4226.8	4304.6	4383.3	50
51	53.8	26.8	4000.8	75.6	51.4	28.1	05.9	84.6	51
52	55.0	28.1	02.0	76.9	52.7	29.4	07.2	85.9	52
53	56.2	29.3	03.3	78.1	53.9	30.7	08.5	87.3	53
54	57.4	30.5	04.5	79.4	55.2	32.0	09.8	88.6	54
55	3858.6	3931.7	4005.7	4080.6	4156.5	4233.3	4311.1	[illegible].9	55
56	59.9	33.0	07.0	81.9	57.7	34.6	12.4	91.2	56
57	61.1	34.2	08.2	83.1	59.0	35.9	13.7	92.5	57
58	62.3	35.4	09.5	84.4	60.3	37.1	15.0	93.9	58
59	63.5	36.7	10.7	85.7	61.6	38.4	16.3	95.2	59
60	3864.7	3937.9	4011.9	4086.9	4162.8	4239.7	4317.6	4396.5	60
	67°	68°	69°	70°	71°	72°	73°	74°	

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	75°	76°	77°	78°	79°	80°	81°	82°	M.
0	4396.5	4476.5	4557.6	4639.8	4723.2	4807.7	4893.6	4980.7	0
1	97.8	77.8	58.9	41.2	24.6	09.2	95.0	82.2	1
2	99.2	79.2	60.3	42.5	26.0	10.6	96.5	83.6	2
3	4400.5	80.5	61.7	43.9	27.4	12.0	97.9	85.1	3
4	01.8	81.9	63.0	45.3	28.8	13.4	99.4	86.6	4
5	4403.1	4483.2	4564.4	4646.7	4730.2	4814.9	4900.8	4988.0	5
6	04.5	84.6	65.7	48.1	31.6	16.3	02.2	89.5	6
7	05.8	85.9	67.1	49.4	33.0	17.7	03.7	91.0	7
8	07.1	87.2	68.5	50.8	34.4	19.1	[illegible].1	92.4	8
9	08.4	88.6	69.8	52.2	35.8	20.5	[illegible].6	93.9	9
10	4409.8	4489.9	4571.2	4653.6	4737.2	4822.0	4908.0	4995.4	10
11	11.1	91.3	72.6	55.0	38.6	23.4	09.5	96.8	11
12	12.4	92.6	73.9	56.4	40.0	24.8	10.9	98.3	12
13	13.8	94.0	75.3	57.7	41.4	26.2	12.4	99.8	13
14	15.1	95.3	76.6	59.1	42.8	27.7	13.8	5001.2	14
15	4416.4	4496.7	4578.0	4660.5	4744.2	4829.1	4915.2	5002.7	15
16	17.7	98.0	79.4	61.9	45.6	30.5	16.7	04.2	16
17	19.1	99.4	80.7	63.3	47.0	31.9	18.1	05.6	17
18	20.4	4500.7	82.1	64.7	48.4	33.4	19.6	07.1	18
19	21.7	02.0	83.5	66.1	49.8	34.8	21.0	08.6	19
20	4423.1	4503.4	4584.8	4667.4	4751.2	4836.2	4922.5	5010.0	20
21	24.4	04.7	86.2	68.8	52.6	37.6	23.9	11.5	21
22	25.7	06.1	87.6	70.2	54.0	39.1	25.4	13.0	22
23	27.0	07.4	89.0	71.6	55.4	40.5	26.8	14.5	23
24	28.4	08.8	90.3	73.0	56.8	41.9	28.3	15.9	24
25	4429.7	4510.1	4591.7	4674.4	4758.3	4843.4	4929.7	5017.4	25
26	31.0	11.5	93.1	75.8	59.7	44.8	31.2	18.9	26
27	32.4	12.8	94.4	77.2	61.1	46.2	32.6	20.3	27
28	33.7	14.2	95.8	78.5	62.5	47.6	34.1	21.8	28
29	35.0	15.5	97.2	79.9	63.9	49.1	35.5	23.3	29
30	4436.4	4516.9	4598.5	4681.3	4765.3	4850.5	4937.0	5024.8	30
31	37.7	18.2	99.9	82.7	66.7	51.9	38.4	26.2	31
32	39.0	19.6	4601.3	84.1	68.1	53.4	39.9	27.7	32
33	40.4	20.9	02.6	85.5	69.5	54.8	41.3	29.2	33
34	41.7	22.3	04.0	86.9	70.9	56.2	42.8	30.7	34
35	4443.0	4523.7	4605.4	4688.3	4772.4	4857.7	4944.2	5032.1	35
36	44.4	25.0	06.8	89.7	73.8	59.1	45.7	33.6	36
37	45.7	26.4	08.1	91.1	75.2	60.5	47.2	35.1	37
38	47.0	27.7	09.5	92.4	76.6	62.0	48.6	36.6	38
39	48.4	29.1	10.9	93.8	78.0	63.4	50.1	38.1	39
40	4449.7	4530.4	4612.2	4695.2	4779.4	4864.8	4951.5	5039.5	40
41	51.1	31.8	13.6	96.6	80.8	66.3	53.0	41.0	41
42	52.4	33.1	15.0	98.0	82.2	67.7	54.4	42.5	42
43	53.7	34.5	16.4	99.4	83.7	69.1	55.9	44.0	43
44	55.1	35.8	17.7	4700.8	85.1	70.6	57.3	45.4	44
45	4456.4	4537.2	4619.1	4702.2	4786.5	4872.0	4958.8	5046.9	45
46	57.7	38.6	20.5	03.6	87.9	73.4	60.3	48.4	46
47	59.1	39.9	21.9	05.0	89.3	74.9	61.7	49.9	47
48	60.4	41.3	23.2	06.4	90.7	76.3	63.2	51.4	48
49	61.7	42.6	24.6	07.8	92.1	77.8	64.6	52.8	49
50	4463.1	4544.0	4626.0	4709.2	4793.6	4879.2	4966.1	5054.3	50
51	64.4	45.3	27.4	10.6	95.0	80.6	67.6	55.8	51
52	65.8	46.7	28.8	12.0	96.4	82.1	69.0	57.3	52
53	67.1	48.1	30.1	13.4	97.8	83.5	70.5	58.8	53
54	68.4	49.4	31.5	14.8	99.2	84.9	71.9	60.3	54
55	4469.8	4550.8	4632.9	4716.2	4800.7	4886.4	4973.4	5061.7	55
56	71.1	52.1	34.3	17.6	02.1	87.8	74.9	63.2	56
57	72.5	53.5	35.6	19.0	03.5	89.3	76.3	64.7	57
58	73.8	54.9	37.0	20.4	04.9	90.7	77.8	66.2	58
59	75.2	56.2	38.4	21.8	06.3	92.1	79.2	67.7	59
60	4470.5	4557.6	4639.8	4723.2	4807.7	4893.6	4980.7	5069.2	60
					79°	80°	81°	82°	

TABLE III.—TANGENT DISTANCES FOR A 1° CURVE.

M.	83°	84°	85°	86°	87°	88°	89°	90°	M.
0	5069.2	5159.0	5250.3	5343.0	5437.2	5533.1	5630.5	5729.7	0
1	70.7	60.5	51.8	44.5	38.8	34.7	32.2	31.3	1
2	72.1	62.0	53.3	46.1	40.4	36.3	33.8	33.0	2
3	73.6	63.5	54.9	47.7	42.0	37.9	35.4	34.7	3
4	75.1	65.0	56.4	49.2	43.6	39.5	37.1	36.3	4
5	5076.6	5166.6	5257.9	5350.8	5445.2	5541.1	5638.7	5738.0	5
6	78.1	68.1	59.5	52.3	46.7	42.7	40.3	39.7	6
7	79.6	69.6	61.0	53.9	48.3	44.3	42.0	41.3	7
8	81.1	71.1	62.5	55.5	49.9	46.0	43.6	43.0	8
9	82.6	72.6	64.1	57.0	51.5	47.6	45.3	44.7	9
10	5084.0	5174.1	5265.6	5358.6	5453.1	5549.2	5646.9	5746.3	10
11	85.5	75.6	67.1	60.1	54.7	50.8	48.6	48.0	11
12	87.0	77.1	68.7	61.7	56.3	52.4	50.2	49.7	12
13	88.5	78.7	70.2	63.3	57.9	54.0	51.8	51.4	13
14	90.0	80.2	71.8	64.8	59.5	55.7	53.5	53.0	14
15	5091.5	5181.7	5273.3	5366.4	5461.0	5557.3	5655.1	5754.7	15
16	93.0	83.2	74.8	68.0	62.6	58.9	56.8	56.4	16
17	94.5	84.7	76.4	69.5	64.2	60.5	58.4	58.1	17
18	96.0	86.2	77.9	71.1	65.8	62.1	60.1	59.7	18
19	97.5	87.7	79.5	72.7	67.4	63.7	61.7	61.4	19
20	5099.0	5189.3	5281.0	5374.2	5469.0	5565.4	5663.4	5763.1	20
21	5100.4	90.8	82.5	75.8	70.6	67.0	65.0	64.8	21
22	01.9	92.3	84.1	77.4	72.2	68.6	66.7	66.4	22
23	03.4	93.8	85.6	78.9	73.8	70.2	68.3	68.1	23
24	04.9	95.3	87.2	80.5	75.4	71.8	70.0	69.8	24
25	5106.4	5196.8	5288.7	5382.1	5477.0	5573.5	5671.6	5771.5	25
26	07.9	98.4	90.3	83.6	78.6	75.1	73.3	73.2	26
27	09.4	99.9	91.8	85.2	80.2	76.7	74.9	74.8	27
28	10.9	5201.4	93.3	86.8	81.8	78.3	76.6	76.5	28
29	12.4	02.9	94.9	88.3	83.4	80.0	78.2	78.2	29
30	5113.9	5204.4	5296.4	5389.9	5484.9	5581.6	5679.9	5779.9	30
31	15.4	06.0	98.0	91.5	86.5	83.2	81.5	81.6	31
32	16.9	07.5	99.5	93.1	88.1	84.8	83.2	83.2	32
33	18.4	09.0	5301.1	94.6	89.7	86.5	84.8	84.9	33
34	19.9	10.5	02.6	96.2	91.3	88.1	86.5	86.6	34
35	5121.4	5212.1	5304.2	5397.8	5492.9	5589.7	5688.1	5788.3	35
36	22.9	13.6	05.7	99.3	94.5	91.3	89.8	90.0	36
37	24.4	15.1	07.3	5400.9	96.1	93.0	91.4	91.7	37
38	25.9	16.6	08.8	02.5	97.7	94.6	93.1	93.3	38
39	27.4	18.2	10.4	04.1	99.3	96.2	94.8	95.0	39
40	5128.9	5219.7	5311.9	5405.6	5500.9	5597.8	5696.4	5796.7	40
41	30.4	21.2	13.5	07.2	02.5	99.5	98.1	98.4	41
42	31.9	22.7	15.0	08.8	04.1	5601.1	99.7	5800.1	42
43	33.4	24.3	16.6	10.4	05.7	02.7	5701.4	01.8	43
44	34.9	25.8	18.1	12.0	07.3	04.4	03.0	03.5	44
45	5136.4	5227.3	5319.7	5413.5	5509.0	5606.0	5704.7	5805.1	45
46	37.9	28.8	21.2	15.1	10.6	07.6	06.4	06.8	46
47	39.4	30.4	22.8	16.7	12.2	09.3	08.0	08.5	47
48	40.9	31.9	24.3	18.3	13.8	10.9	09.7	10.2	48
49	42.4	33.4	25.9	19.8	15.4	12.5	11.3	11.9	49
50	5143.9	5234.9	5327.4	5421.4	5517.0	5614.2	5713.0	5813.6	50
51	45.4	36.5	29.0	23.0	18.6	15.8	14.7	15.3	51
52	46.9	38.0	30.5	24.6	20.2	17.4	16.3	17.0	52
53	48.4	39.5	32.1	26.2	21.8	19.1	18.0	18.7	53
54	50.0	41.1	33.6	27.7	23.4	20.7	19.7	20.4	54
55	5151.5	5242.6	5335.2	5429.3	5525.0	5622.3	5721.3	5822.1	55
56	53.0	44.1	36.8	30.9	26.6	24.0	23.0	23.8	56
57	54.5	45.7	38.3	32.5	28.2	25.6	24.7	25.4	57
58	56.0	47.2	39.9	34.1	29.8	27.2	26.3	27.1	58
59	57.5	48.7	41.4	35.7	31.4	28.9	28.0	28.8	59
60	5159.0	5250.3	5343.0	5437.2	5533.1	5630.5	5729.7	5830.5	60
	83°	84°	85°	86°	87°	88°	89°	90°	

M.	91°	92°	93°	94°	95°	96°	97°
0	5830.5	5933.2	6037.8	6144.3	6252.8	6363.4	6476.2
1	32.2	35.0	39.6	46.1	54.6	65.3	78.1
2	33.9	36.7	41.3	47.9	56.5	67.1	80.0
3	35.6	38.4	43.1	49.7	58.3	69.0	81.9
4	37.3	40.1	44.8	51.5	60.1	70.9	83.8
5	5839.0	5941.9	6046.6	6153.3	6262.0	6372.7	6485.7
6	40.7	43.6	48.4	55.1	63.8	74.6	87.6
7	42.4	45.3	50.1	56.9	65.6	76.5	89.5
8	44.1	47.1	51.9	58.6	67.4	78.3	91.4
9	45.8	48.8	53.6	60.4	69.3	80.2	93.3
10	5847.5	5950.5	6055.4	6162.2	6271.1	6382.1	6495.2
11	49.2	52.3	57.2	64.0	72.9	83.9	97.1
12	50.9	54.0	58.9	65.8	74.8	85.8	99.0
13	52.6	55.7	60.7	67.6	76.6	87.7	6500.9
14	54.3	57.5	62.5	69.4	78.4	89.5	02.8
15	5856.0	5959.2	6064.2	6171.2	6280.3	6391.4	6504.7
16	57.7	60.9	66.0	73.0	82.1	93.3	06.6
17	59.4	62.7	67.8	74.8	83.9	95.2	08.5
18	61.1	64.4	69.5	76.6	85.8	97.0	10.5
19	62.9	66.1	71.3	78.4	87.6	98.9	12.4
20	5864.6	5967.9	6073.1	6180.2	6289.4	6400.8	6514.3
21	66.3	69.6	74.8	82.0	91.3	02.6	16.2
22	68.0	71.3	76.6	83.9	93.1	04.5	18.1
23	69.7	73.1	78.4	85.7	95.0	06.4	20.0
24	71.4	74.8	80.2	87.5	96.8	08.3	21.9
25	5873.1	5976.6	6081.9	6189.3	6298.6	6410.1	6523.8
26	74.8	78.3	83.7	91.1	6300.5	12.0	25.8
27	76.5	80.0	85.5	92.9	02.3	13.9	27.7
28	78.2	81.8	87.2	94.7	04.2	15.8	29.6
29	79.9	83.5	89.0	96.5	06.0	17.7	31.5
30	5881.7	5985.3	6090.8	6198.3	6307.9	6419.5	6533.4
31	83.4	87.0	92.6	6200.1	09.7	21.4	35.3
32	85.1	88.8	94.3	01.9	11.5	23.3	37.2
33	86.8	90.5	96.1	03.7	13.4	25.2	39.2
34	88.5	92.2	97.9	05.5	15.2	27.1	41.1
35	5890.2	5994.0	6099.7	6207.4	6317.1	6428.9	6543.0
36	91.9	95.7	6101.5	09.2	18.9	30.8	44.9
37	93.6	97.5	03.2	11.0	20.8	32.7	46.8
38	95.4	99.2	05.0	12.8	22.6	34.6	48.8
39	97.1	6001.0	06.8	14.6	24.5	36.5	50.7
40	5898.8	6002.7	6108.6	6216.4	6326.3	6438.4	6552.6
41	5900.5	04.5	10.4	18.2	28.2	40.2	54.5
42	02.2	06.2	12.1	20.0	30.0	42.1	56.5
43	03.9	08.0	13.9	21.9	31.9	44.0	58.4
44	05.7	09.7	15.7	23.7	33.7	45.9	60.3
45	5907.4	6011.5	6117.5	6225.5	6335.6	6447.8	6562.2
46	09.1	13.2	19.3	27.3	37.4	49.7	64.2
47	10.8	15.0	21.1	29.1	39.3	51.6	66.1
48	12.5	16.7	22.8	30.9	41.1	53.5	68.0
49	14.3	18.5	24.6	32.8	43.0	55.4	70.0
50	5916.0	6020.2	6126.4	6234.6	6344.8	6457.2	6571.9
51	17.7	22.0	28.2	36.4	46.7	59.1	73.8
52	19.4	23.7	30.0	38.2	48.6	61.0	75.7
53	21.2	25.5	31.8	40.0	50.4	62.9	77.7
54	22.9	27.2	33.6	41.9	52.3	64.8	79.6
55	5924.6	6029.0	6135.3	6243.7	6354.1	6466.7	6581.5
56	26.3	30.8	37.1	45.5	56.0	68.6	83.5
57	28.0	32.5	38.9	47.3	57.8	70.5	85.4
58	29.8	34.3	40.7	49.2	59.7	72.4	87.3
59	31.5	36.0	42.5	51.0	61.6	74.3	89.3
60	5933.2	6037.8	6144.3	6252.8	6363.4	6476.2	6591.2
	91°	92°	93°	94°	95°	96°	97°

TABLE IV.—CORRECTIONS FOR TANGENT DISTANCES.

Int. Ang. I	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	Int. Ang. I
	DEGREE OF CURVE.												
1°	.00	.00	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	1°
2	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.02	.02	2
3	.00	.01	.01	.01	.01	.01	.02	.02	.02	02	.02	.02	3
4	.00	.01	.01	.01	.01	.02	.02	.02	.03	.03	.03	.03	4
5	.00	.01	.01	.02	.02	.02	.03	.03	.03	.03	.04	.04	5
6	.01	.01	.01	.02	.02	.03	.03	.03	.04	.04	.05	.05	6
7	.01	.01	.02	.02	.03	.03	.04	.04	.04	.05	.05	.06	7
8	.01	.01	.02	.02	.03	.03	.04	.05	.05	.06	.06	.07	8
9	.01	.02	.02	.03	.03	.04	.05	.05	.06	.06	.07	.07	9
10	.01	.02	.02	.03	.04	.04	.05	.06	.06	.07	.08	.08	10
11	.01	.02	.03	.03	.04	.05	.06	.06	.07	.08	.08	.09	11
12	.01	.02	.03	.04	.04	.05	.06	.07	.08	.08	.09	.10	12
13	.01	.02	.03	.04	.05	.06	.07	.07	.08	.09	.10	.11	13
14	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	14
15	.01	.03	.04	.05	.06	.07	.08	.09	.09	.10	.11	.12	15
16	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	.13	16
17	.02	.03	.04	.05	.06	.07	.09	.10	.11	.12	.13	.14	17
18	.02	.03	.04	.06	.07	.08	.09	.10	.11	.13	.14	.15	18
19	.02	.03	.05	.06	.07	.08	.10	.11	.12	.13	.15	.16	19
20	.02	.03	.05	.06	.07	.09	.10	.11	.13	.14	.15	.17	20
21	.02	.04	.05	.06	.08	.09	.11	.12	.13	.15	.16	.17	21
22	.02	.04	.05	.07	.08	.10	.11	.13	.14	.15	.17	.18	22
23	.02	.04	.06	.07	.09	.10	.12	.13	.15	.16	.18	.19	23
24	.02	.04	.06	.07	.09	.11	.12	.14	.15	.17	.18	.20	24
25	.02	.04	.06	.08	.09	.11	.13	.14	.16	.18	.19	.21	25
26	.03	.04	06	.08	.10	.12	.13	.15	.17	.18	.20	.22	26
27	.03	.05	.07	.08	.10	.12	.14	.16	.17	.19	.21	.23	27
28	.03	.05	.07	.09	.11	.12	.14	.16	.18	.20	.22	.23	28
29	.03	.05	.07	.09	.11	.13	.15	.17	.19	.21	.22	.24	29
30	.03	.05	.07	.09	.11	.13	.15	.17	.19	.21	.23	.25	30
31	.03	.05	.08	.10	.12	.14	.16	.18	.20	.22	.24	.26	31
32	.03	.06	.08	.10	.12	.14	.16	.19	.21	.23	.25	.27	32
33	.03	.06	.08	.10	.13	.15	.17	.19	.21	.24	.26	.28	33
34	.03	.06	.08	.11	.13	.15	.18	.20	.22	.24	.27	.29	34
35	.03	.06	.09	.11	.13	.16	.18	.20	.23	.25	.27	.30	35
36	.04	.06	.09	.11	.14	16	.19	.21	.23	.26	.28	.31	36
37	.04	.06	.09	.12	.14	.17	.19	.22	.24	.27	.29	.31	37
38	.04	.07	.09	.12	.15	.17	.20	.22	.25	.27	.30	.32	38
39	.04	.07	.10	.12	.15	.18	.20	.23	.26	.28	.31	.33	39
40	.04	.07	.10	.13	.15	.18	.21	.24	.26	.29	.32	.34	40
41	.04	.07	.10	.13	.16	.19	.21	.24	.27	.30	.32	.35	41
42	04	.07	.10	.13	.16	.19	.22	.25	.28	.30	.33	.36	42
43	.04	.08	.11	.14	.17	.20	.23	.25	.28	.31	.34	.37	43
44	.04	.08	.11	.14	.17	.20	.23	.26	.29	.32	.35	.38	44
45	.05	.08	.11	.14	.18	.21	.24	.27	.30	.33	.36	.39	45
46	.05	.08	.12	.15	.18	.21	.24	.27	.31	.34	.37	.40	46
47	.05	.08	.12	.15	.18	.22	.25	.28	.31	.35	.38	.41	47
48	.05	.09	.12	.16	.19	.22	.26	.29	.32	.35	.39	.42	48
49	.05	.09	.12	.16	.19	.23	.26	.29	.33	.36	.40	.43	49
50	.05	.09	.13	.16	.20	.23	.27	.30	.34	.37	.40	.44	50
51	.05	.09	.13	.17	.20	.24	.27	.31	.34	.38	.41	.45	51
52	.05	.09	.13	.17	.21	.24	.28	.32	.35	.39	.42	.46	52
53	.05	.10	.14	.17	.21	.25	.29	.32	.36	.40	.43	.47	53
54	.06	.10	.14	.18	.22	.25	.29	.33	.37	.40	.44	.48	54
55	.06	.10	.14	.18	.22	.26	.30	.34	.38	.41	.45	.49	55
56	.06	.10	.15	.19	.23	.27	.30	.34	.38	.42	.46	.50	56
57	.06	.11	.15	.19	.23	.27	.31	.35	.39	.43	.47	.51	57
58	.06	.11	.15	.19	.24	.28	.32	.36	.40	.44	.48	.52	58
59	.06	.11	.15	.20	.24	.28	.32	.37	.41	.45	.49	.53	59
60	.06	.11	.16	.20	.24	.29	.33	.37	.42	.46	.50	.54	60
	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	

TABLE IV.—CORRECTION

Int. Ang. I	DEGREE					
	2°	3°	4°	5°	6°	7°
61°	.06	.11	.16	.21	.25	.29
62	.07	.12	.16	.21	.25	.30
63	.07	.12	.17	.21	.26	.31
64	.07	.12	.17	.22	.27	.31
65	.07	.12	.17	.22	.27	.32
66	.07	.13	.18	.23	.28	.32
67	.07	.13	.18	.23	.28	33
68	.07	.13	.18	.24	.29	.34
69	.07	.13	.19	.24	.29	.34
70	.08	.14	.19	.24	.30	.35
71	.08	.14	.19	.25	.30	.36
72	.08	.14	.20	.25	.31	.36
73	.08	.14	.20	.26	.31	.37
74	.08	.15	.21	.26	.32	.38
75	.08	.15	.21	.27	.33	.38
76	.09	.15	.21	.27	.33	.39
77	.09	.15	.22	.28	.34	.40
78	.09	.16	.22	.28	.34	.40
79	.09	.16	.22	.29	.35	.41
80	.09	.16	.23	.29	.36	.42
81	.09	.17	.23	.30	.36	.43
82	.09	.17	.24	.30	.37	.43
83	.10	.17	.24	.31	.38	.44
84	.10	.17	.25	.31	.38	.45
85	.10	.18	.25	.32	.39	.46
86	.10	.18	.25	.33	.40	.47
87	.10	.18	.26	.33	.40	.47
88	.11	.19	.26	.34	.41	.48
89	.11	.19	.27	.34	.42	.49
90	.11	.19	.27	.35	.42	.50
91	.11	.20	.28	.36	.43	.51
92	.11	.20	.28	.36	.44	.52
93	.11	.20	.29	.37	.45	.53
94	.12	.21	.29	.37	.46	.53
95	.12	.21	.30	.38	.46	.54
96	.12	.22	.30	.39	.47	.55
97	.12	.22	.31	.39	.48	.56
98	.13	.22	.31	.40	.49	.57
99	.13	.23	.32	.41	.50	.58
100	.13	.23	.33	.42	.51	.59
101	.13	.24	.33	.42	.51	.61
102	.13	.24	.34	.43	.52	.62
103	.14	.24	.34	.44	.53	.63
104	.14	.25	.35	.45	.54	.64
105	.14	.25	.36	.46	.55	.65
106	.14	.26	.36	.46	.56	.66
107	.15	.26	.37	47	.57	.67
108	.15	.27	.38	.48	.58	.69
109	.15	.27	.38	.49	.59	.70
110	.16	.28	.39	.50	.61	.71
111	.16	.28	.40	.51	.62	.73
112	.16	.29	.40	.52	.63	.74
113	.16	.29	.41	.53	.64	.75
114	.17	.30	.42	.54	.65	.77
115	.17	.30	.43	.55	.67	.78
116	.17	.31	.44	.56	.68	.80
117	.18	.32	.45	.57	.69	.81
118	.18	.32	.45	.58	.71	.83
119	19	.33	.46	.59	.72	.85
120	.19	.34	.47	.60	.73	.86
	2°	3°	4°	5°	6°	7°

TABLE V.—EXTERNAL DISTANCES FOR A 1° CURVE.

Angle I.	Ext. Dis.	Angle I.	Ext. Dis.	Angle I.	Ext. Dis.	Angle I.	Ext. Dis.	Angle I.	Ext. Dis.	Angle I.	Ext. Dis.
1° 0'	.2	11° 0'	26.5	21° 0'	97.6	31° 0'	216.2	41° 0'	387.4	51° 0'	618.4
10	.3	10	27.3	10	99.2	10	218.7	10	390.7	10	622.8
20	.4	20	28.1	20	100.7	20	221.1	20	394.1	20	627.2
30	.5	30	29.0	30	102.3	30	223.5	30	397.4	30	631.7
40	.6	40	29.8	40	104.0	40	226.0	40	400.8	40	636.2
50	.7	50	30.7	50	105.6	50	228.4	50	404.2	50	640.7
2° 0	.9	12° 0	31.6	22° 0	107.2	32° 0	230.9	42° 0	407.6	52° 0	645.2
10	1.0	10	32.4	10	108.9	10	233.4	10	411.1	10	649.7
20	1.2	20	33.3	20	110.6	20	235.9	20	414.5	20	654.3
30	1.4	30	34.3	30	112.3	30	238.4	30	418.0	30	658.8
40	1.6	40	35.2	40	113.9	40	241.0	40	421.5	40	663.4
50	1.8	50	36.1	50	115.7	50	243.5	50	425.0	50	668.0
3° 0	2.0	13° 0	37.1	23° 0	117.4	33° 0	246.1	43° 0	428.5	53° 0	672.7
10	2.2	10	38.0	10	119.1	10	248.7	10	432.0	10	677.3
20	2.4	20	39.0	20	120.9	20	251.3	20	435.6	20	682.0
30	2.7	30	40.0	30	122.6	30	253.9	30	439.2	30	686.7
40	2.9	40	41.0	40	124.4	40	256.5	40	442.7	40	691.4
50	3.2	50	42.0	50	126.2	50	259.1	50	446.4	50	696.1
4° 0	3.5	14° 0	43.0	24° 0	128.0	34° 0	261.8	44° 0	450.0	54° 0	700.9
10	3.8	10	44.1	10	129.8	10	264.5	10	453.6	10	705.7
20	4.1	20	45.1	20	131.7	20	267.2	20	457.3	20	710.5
30	4.4	30	46.2	30	133.5	30	269.9	30	460.9	30	715.3
40	4.8	40	47.3	40	135.4	40	272.6	40	464.6	40	720.1
50	5.1	50	48.3	50	137.2	50	275.3	50	468.4	50	725.0
5° 0	5.5	15° 0	49.4	25° 0	139.1	35° 0	278.1	45° 0	472.1	55° 0	729.9
10	5.8	10	50.6	10	141.0	10	280.8	10	475.8	10	734.8
20	6.2	20	51.7	20	142.9	20	283.6	20	479.6	20	739.7
30	6.6	30	52.8	30	144.9	30	286.4	30	483.4	30	744.6
40	7.0	40	54.0	40	146.8	40	289.2	40	487.2	40	749.6
50	7.4	50	55.1	50	148.7	50	292.0	50	491.0	50	754.6
6° 0	7.9	16° 0	56.3	26° 0	150.7	36° 0	294.9	46° 0	494.8	56° 0	759.6
10	8.3	10	57.5	10	152.7	10	297.7	10	498.7	10	764.6
20	8.8	20	58.7	20	154.7	20	300.6	20	502.5	20	769.7
30	9.2	30	59.9	30	156.7	30	303.5	30	506.4	30	774.7
40	9.7	40	61.1	40	158.7	40	306.4	40	510.3	40	779.8
50	10.2	50	62.4	50	160.8	50	309.3	50	514.3	50	784.9
7° 0	10.7	17° 0	63.6	27° 0	162.8	37° 0	312.2	47° 0	518.2	57° 0	790.1
10	11.2	10	64.9	10	164.9	10	315.2	10	522.2	10	795.2
20	11.8	20	66.2	20	167.0	20	318.1	20	526.1	20	800.4
30	12.3	30	67.5	30	169.0	30	321.1	30	530.1	30	805.6
40	12.8	40	68.8	40	171.2	40	324.1	40	534.1	40	810.9
50	13.4	50	70.1	50	173.3	50	327.1	50	538.2	50	816.1
8° 0	14.0	18° 0	71.4	28° 0	175.4	38° 0	330.1	48° 0	542.2	58° 0	821.4
10	14.6	10	72.8	10	177.6	10	333.2	10	546.3	10	826.7
20	15.2	20	74.1	20	179.7	20	336.2	20	550.4	20	832.0
30	15.8	30	75.5	30	181.9	30	339.3	30	554.5	30	837.3
40	16.4	40	76.9	40	184.1	40	342.4	40	558.6	40	842.7
50	17.1	50	78.3	50	186.3	50	345.5	50	562.8	50	848.1
9° 0	17.7	19° 0	79.7	29° 0	188.5	39° 0	348.6	49° 0	566.9	59° 0	853.5
10	18.4	10	81.1	10	190.7	10	351.8	10	571.1	10	858.9
20	19.1	20	82.5	20	193.0	20	354.9	20	575.3	20	864.3
30	19.7	30	84.0	30	195.2	30	358.1	30	579.5	30	869.8
40	20.4	40	85.4	40	197.5	40	361.3	40	583.8	40	875.3
50	21.2	50	86.9	50	199.8	50	364.5	50	588.0	50	880.8
10° 0	21.9	20° 0	88.4	30° 0	202.1	40° 0	367.7	50° 0	592.3	60° 0	886.4
10	22.6	10	89.9	10	204.4	10	371.0	10	596.6	10	891.9
20	23.4	20	91.4	20	206.8	20	374.2	20	600.9	20	897.5
30	24.1	30	92.9	30	209.1	30	377.5	30	605.3	30	903.2
40	24.9	40	94.5	40	211.5	40	380.8	40	609.6	40	908.8
50	25.7	50	96.0	50	213.9	50	384.1	50	614.0	50	914.5

TABLE V.—EXTERNAL DISTANCES FOR A 1° CURVE.

Angle I.	Ext. Dis.	Angle I.	Ext. Dis.	A		Angle I.	Ext. Dis.		
61° 0'	920.1	71° 0'	1308.2	81° 0'	1805.3	91° 0'	2444.9	101° 0'	3278.1
10	925.8	10	1315.5	10	1814.7	10	2457.1	10	3294.1
20	931.6	20	1322.9	20	1824.1	20	2469.3	20	3310.1
30	937.3	30	1330.3	30	1833.6	30	2481.5	30	3326.1
40	943.1	40	1337.7	40	1843.1	40	2493.8	[illegible]	3342.3
50	948.9	50	1345.1	50	1852.6	50	2506.1	50	3358.5
62° 0	954.8	72° 0	1352.6	82° 0	1862.2	92° 0	2518.5	102° 0	3374.9
10	960.6	10	1360.1	10	1871.8	10	2531.0	10	3391.2
20	966.5	20	1367.6	20	1881.5	20	2543.5	20	3407.7
30	972.4	30	1375.2	30	1891.2	30	2556.0	[illegible]	3424.3
40	978.3	40	1382.8	[illegible]	1900.9	40	2568.6	40	3440.9
50	984.3	50	1390.4	50	1910.7	50	2581.3	50	3457.6
63° 0	990.2	73° 0	1398.0	83° 0	1920.5	93° 0	2594.0	103° 0	3474.4
10	996.2	10	1405.7	10	1930.4	10	2606.8	10	3491.3
20	1002.3	20	1413.5	20	1940.3	20	2619.7	20	3508.2
30	1008.3	30	1421.2	30	1950.3	30	2632.6	30	3525.2
40	1014.4	40	1429.0	40	1960.2	40	2645.5	40	3542.4
50	1020.5	50	1436.8	50	1970.3	50	2658.5	50	3559.6
64° 0	1026.6	74° 0	1444.6	84° 0	1980.4	94° 0	2671.6	104° 0	3576.8
10	1032.8	10	1452.5	10	1990.5	10	2684.7	10	3594.2
20	1039.0	20	1460.4	20	2000.6	20	2697.9	20	3611.7
30	1045.2	30	1468.4	30	2010.8	30	2711.2	30	3629.2
40	1051.4	40	1476.4	40	2021.1	40	2724.5	40	3646.8
50	1057.7	50	1484.4	50	2031.4	50	2737.9	50	3664.5
65° 0	1063.9	75° 0	1492.4	85° 0	2041.7	95° 0	2751.3	105° 0	3682.3
10	1070.2	10	1500.5	10	2052.1	10	2764.8	10	3700.2
20	1076.6	20	1508.6	20	2062.5	20	2778.3	20	3718.2
30	1082.9	30	1516.7	30	2073.0	30	2792.0	30	3736.2
40	1089.3	40	1524.9	40	2083.5	40	2805.6	40	3754.4
50	1095.7	50	1533.1	50	2094.1	50	2819.4	50	3772.6
66° 0	1102.2	76° 0	1541.4	86° 0	2104.7	96° 0	2833.2	106° 0	3791.0
10	1108.6	10	1549.7	10	2115.3	10	2847.0	10	3809.4
20	1115.1	20	1558.0	20	2126.0	20	2861.0	20	3827.9
30	1121.7	30	1566.3	[illegible]	2136.7	30	2875.0	30	3846.5
40	1128.2	40	1574.7	40	2147.5	40	2889.0	40	3865.2
50	1134.8	50	1583.1	50	2158.4	50	2903.1	50	3884.0
67° 0	1141.4	77° 0	1591.6	87° 0	2169.2	97° 0	2917.3	107° 0	3902.9
10	1148.0	10	1600.1	10	2180.2	10	2931.6	10	3921.9
20	1154.7	20	1608.6	20	2191.1	20	2945.9	20	3940.9
30	1161.3	30	1617.1	30	2202.2	30	2960.3	30	3960.1
40	1168.1	[illegible]	1625.7	40	2213.2	40	2974.7	40	3979.4
50	1174.8	50	1634.4	50	2224.3	50	2989.2	50	3998.7
68° 0	1181.6	78° 0	1643.0	88° 0	2235.5	98° 0	3003.8	108° 0	4018.0
10	1188.4	10	1651.7	10	2246.7	10	3018.4	10	4037.8
20	1195.2	20	1660.5	20	2258.0	20	3033.1	20	4057.4
30	1202.0	30	1669.2	30	2269.3	30	3047.9	30	4077.2
40	1208.9	40	1678.1	40	2280.6	40	3062.8	40	4097.1
50	1215.8	50	1686.9	50	2292.0	50	3077.7	50	4117.0
69° 0	1222.7	79° 0	1695.8	89° 0	2303.5	99° 0	3092.7	109° 0	4137.1
10	1229.7	10	1704.7	10	2315.0	10	3107.7	10	4157.3
20	1236.7	20	1713.7	20	2326.6	20	3122.9	20	4177.5
30	1243.7	30	1722.7	30	2338.2	30	3138.1	30	4197.9
40	1250.8	[illegible]	1731.7	40	2349.8	40	3153.3	40	4218.4
50	1257.8	50	1740.8	50	2361.5	50	3168.7	50	4239.0
70° 0	1265.0	80° 0	1749.9	90° 0	2373.3	100° 0	3184.1	110° 0	4259.7
10	1272.1	10	1759.0	10	2385.1	10	3199.6	10	4280.5
20	1279.3	20	1768.2	20	2397.0	20	3215.1	20	4301.4
30	1286.5	30	1777.4	30	2408.9	30	3230.8	30	4322.4
40	1293.7	40	1786.7	40	2420.9	40	3246.5	40	4343.6
50	1300.9	50	1796.0	50	2432.9	50	3262.3	50	4364.8

TABLE VI.—SPIRAL FOR 1°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	0.3°	30.00	0.03	60.00	0.10	60.00	0°18′
80	0.4	40.00	0.05	80.00	0.19	80.00	0 24
100	0.5	50.00	0.07	100.00	0.29	100.00	0 30
120	0.6	60.00	0.10	120.00	0.42	120.00	0 36
140	0.7	70.00	0.14	140.00	0.57	140.00	0 42
160	0.8	80.00	0.19	160.00	0.74	160.00	0 48
180	0.9	90.00	0.24	180.00	0.94	180.00	0 54
200	1.0	100.00	0.29	199.99	1.16	200.00	1 00
220	1.1	110.00	0.35	219.99	1.41	220.00	1 06
240	1.2	120.00	0.42	239.99	1.68	240.00	1 12
260	1.3	130.00	0.49	259.99	1.97	259.99	1 18
280	1.4	140.00	0.57	279.98	2.28	279.99	1 24
300	1.5	149.99	0.65	299.98	2.62	299.99	1 30
320	1.6	159.99	0.74	319.98	2.98	319.99	1 36
340	1.7	169.99	0.84	339.97	3.36	339.99	1 42
360	1.8	179.99	0.94	359.97	3.77	359.98	1 48
380	1.9	189.99	1.05	379.96	4.20	379.98	1 54
400	2.0	199.99	1.16	399.95	4.65	399.98	2 00
420	2.1	209.99	1.28	419.94	5.13	419.98	2 06
440	2.2	219.99	1.41	439.94	5.63	439.97	2 12
460	2.3	229.99	1.54	459.93	6.15	459.97	2 18
480	2.4	239.98	1.68	479.92	6.70	479.96	2 24
500	2.5	249.98	1.82	499.91	7.27	499.96	2 30
520	2.6	259.98	1.97	519.89	7.86	519.95	2 36
540	2.7	269.98	2.12	539.88	8.48	539.95	2 42
560	2.8	279.98	2.28	559.87	9.12	559.94	2 48
580	2.9	289.97	2.45	579.85	9.78	579.94	2 54
600	3.0°	299.97	2.62	599.84	10.47	599.93	3°00′

SPIRAL FOR 1°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	0.45°	30.00	0.04	60.00	0.16	60.00	0°27′
80	0.60	40.00	0.07	80.00	0.28	80.00	0 36
100	0.75	50.00	0.11	100.00	0.44	100.00	0 45
120	0.90	60.00	0.16	120.00	0.63	120.00	0 54
140	1.05	70.00	0.21	140.00	0.86	140.00	1 03
160	1.20	80.00	0.28	159.99	1.12	160.00	1 12
180	1.35	90.00	0.35	179.99	1.41	180.00	1 21
200	1.50	99.99	0.44	199.99	1.75	199.99	1 30
220	1.65	109.99	0.53	219.98	2.11	219.99	1 39
240	1.80	119.99	0.63	239.98	2.51	239.99	1 48
260	1.95	129.99	0.74	259.97	2.95	259.99	1 57
280	2.10	139.99	0.86	279.96	3.42	279.98	2 06
300	2.25	149.99	0.98	299.95	3.93	299.98	2 15
320	2.40	159.99	1.12	319.94	4.47	319.98	2 24
340	2.55	169.98	1.26	339.93	5.04	339.97	2 33
360	2.70	179.98	1.41	359.92	5.65	359.97	2 42
380	2.85	189.98	1.57	379.91	6.30	379.96	2 51
400	3.00	199.98	1.75	399.89	6.98	399.95	3 00
420	3.15	209.97	1.92	419.87	7.70	419.94	3 09
440	3.30	219.97	2.11	439.85	8.45	439.94	3 18
460	3.45	229.97	2.31	459.83	9.23	459.93	3 27
480	3.60	239.96	2.51	479.81	10.05	479.92	3 36
500	3.75	249.96	2.73	499.79	10.90	499.91	3 45
520	3.90	259.95	2.95	519.76	11.79	519.89	3 54
540	4.05	269.95	3.18	539.73	12.72	539.88	4 03
560	4.20	279.94	3.42	559.70	13.68	559.87	4 12
580	4.35	289.94	3.67	579.67	14.67	579.85	4 21
600	4.50°	299.93	3.93	599.63	15.70	599.84	4°30′

TABLE VI. — SPIRAL FOR 2°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	0.6°	30.00	0.05	60.00	0.21	60.00	0°36′
80	0.8	40.00	0.09	80.00	0.37	80.00	0 48
100	1.0	50.00	0.15	100.00	0.58	100.00	1 00
120	1.2	60.00	0.21	119.99	0.84	120.00	1 12
140	1.4	70.00	0.29	139.99	1.14	140.00	1 24
160	1.6	79.99	0.37	159.99	1.49	159.99	1 36
180	1.8	89.99	0.47	179.98	1.88	179.99	1 48
200	2.0	99.99	0.58	199.98	2.33	199.99	2 00
220	2.2	109.99	0.70	219.97	2.82	219.99	2 12
240	2.4	119.99	0.84	239.96	3.35	239.98	2 24
260	2.6	129.98	0.98	259.95	3.93	259.98	2 36
280	2.8	139.98	1.14	279.93	4.56	279.97	2 48
300	3.0	149.98	1.31	299.92	5.24	299.96	3 00
320	3.2	159.98	1.49	319.90	5.96	319.96	3 12
340	3.4	169.97	1.68	339.88	6.72	339.95	3 24
360	3.6	179.97	1.88	359.86	7.54	359.94	3 36
380	3.8	189.96	2.10	379.83	8.40	379.93	3 48
400	4.0	199.96	2.33	399.81	9.31	399.91	4 00
420	4.2	209.95	2.56	419.78	10.26	419.90	4 12
440	4.4	219.95	2.81	439.74	11.26	439.89	4 24
460	4.6	229.94	3.08	459.71	12.31	459.87	4 36
480	4.8	239.93	3.35	479.66	13.40	479.85	4 48
500	5.0	249.93	3.63	499.62	14.54	499.83	5 00
520	5.2	259.92	3.93	519.57	15.72	519.81	5 12
540	5.4	269.91	4.24	539.52	16.95	539.79	5 24
560	5.6	279.90	4.56	559.47	18.23	559.77	5 36
580	5.8	289.89	4.89	579.41	19.56	579.74	5 48
600	6.0°	299.88	5.23	599.35	20.93	599.71	6°00′

SPIRAL FOR 2°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	0.75°	30.00	0.07	60.00	0.26	60.00	0°45′
80	1.00	40.00	0.12	80.00	0.47	80.00	1 00
100	1.25	50.00	0.18	100.00	0.73	100.00	1 15
120	1.50	59.99	0.26	119.99	1.05	120.00	1 30
140	1.75	69.99	0.36	139.99	1.43	139.99	1 45
160	2.00	79.99	0.47	159.98	1.86	159.99	2 00
180	2.25	89.99	0.59	179.97	2.36	179.99	2 15
200	2.50	99.99	0.73	199.96	2.91	199.98	2 30
220	2.75	109.98	0.88	219.95	3.52	219.98	2 45
240	3.00	119.98	1.05	239.93	4.19	239.97	3 00
260	3.25	129.98	1.23	259.92	4.91	259.96	3 15
280	3.50	139.97	1.42	279.90	5.70	279.95	3 30
300	3.75	149.97	1.64	299.87	6.54	299.94	3 45
320	4.00	159.96	1.86	319.84	7.44	319.93	4 00
340	4.25	169.96	2.10	339.81	8.40	339.92	4 15
360	4.50	179.95	2.36	359.78	9.42	359.90	4 30
380	4.75	189.94	2.62	379.74	10.50	379.89	4 45
400	5.00	199.94	2.91	399.70	11.63	399.87	5 00
420	5.25	209.93	3.21	419.65	12.82	419.85	5 15
440	5.50	219.92	3.52	439.60	14.07	439.82	5 30
460	5.75	229.91	3.84	459.54	15.38	459.80	5 45
480	6.00	239.90	4.19	479.48	16.74	479.77	6 00
500	6.25	249.88	4.54	499.41	18.17	499.74	6 15
520	6.50	259.87	4.91	519.33	19.65	519.71	6 30
540	6.75	269.86	5.30	539.25	21.18	539.67	6 45
560	7.00	279.84	5.70	559.17	22.78	559.63	7 00
580	7.25	289.83	6.11	579.08	24.44	579.59	7 15
600	7.50°	299.81	6.54	598.98	26.15	599.55	7°30′

TABLE VI.—SPIRAL FOR 3°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	0.9°	30.00	0.08	60.00	0.31	60.00	0°54′
80	1.2	39.99	0.14	80.00	0.56	80.00	1 12
100	1.5	49.99	0.22	99.99	0.87	100.00	1 30
120	1.8	59.99	0.31	119.99	1.26	119.99	1 48
140	2.1	69.99	0.43	139.98	1.71	139.99	2 06
160	2.4	79.99	0.56	159.97	2.23	159.99	2 24
180	2.7	89.98	0.71	179.96	2.83	179.98	2 42
200	3.0	99.98	0.87	199.95	3.49	199.98	3 00
220	3.3	109.98	1.06	219.93	4.22	219.97	3 18
240	3.6	119.97	1.26	239.91	5.03	239.96	3 36
260	3.9	129.97	1.47	259.88	5.90	259.95	3 54
280	4.2	139.96	1.71	279.85	6.84	279.93	4 12
300	4.5	149.95	1.96	299.82	7.85	299.92	4 30
320	4.8	159.95	2.23	319.78	8.93	319.90	4 48
340	5.1	169.94	2.52	339.73	10.08	339.88	5 06
360	5.4	179.93	2.83	359.68	11.30	359.86	5 24
380	5.7	189.92	3.15	379.63	12.59	379.84	5 42
400	6.0	199.91	3.49	399.56	13.95	399.81	6 00
420	6.3	209.89	3.85	419.50	15.38	419.78	6 18
440	6.6	219.88	4.22	439.42	16.88	439.74	6 36
460	6.9	229.87	4.61	459.34	18.45	459.71	6 54
480	7.2	239.85	5.02	479.25	20.08	479.67	7 12
500	7.5°	249.83	5.45	499.15	21.79	499.62	7°30′

SPIRAL FOR 3°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.05°	30.00	0.09	60.00	0.37	60.00	1°03′
80	1.40	39.99	0.16	80.00	0.65	80.00	1 24
100	1.75	49.99	0.25	99.99	1.02	100.00	1 45
120	2.10	59.99	0.37	119.98	1.47	119.99	2 06
140	2.45	69.99	0.50	139.97	2.00	139.99	2 27
160	2.80	79.98	0.65	159.96	2.61	159.98	2 48
180	3.15	89.98	0.82	179.95	3.30	179.98	3 09
200	3.50	99.97	1.02	199.93	4.07	199.97	3 30
220	3.85	109.97	1.23	219.90	4.93	219.96	3 51
240	4.20	119.96	1.47	239.87	5.86	239.94	4 12
260	4.55	129.95	1.72	259.84	6.88	259.93	4 33
280	4.90	139.95	1.99	279.80	7.98	279.91	4 54
300	5.25	149.94	2.29	299.75	9.16	299.89	5 15
320	5.60	159.93	2.60	319.70	10.42	319.87	5 36
340	5.95	169.92	2.94	339.64	11.76	339.84	5 57
360	6.30	179.90	3.30	359.57	13.18	359.81	6 18
380	6.65	189.89	3.67	379.49	14.69	379.78	6 39
400	7.00	199.87	4.07	399.41	16.27	399.74	7 00
420	7.35	209.86	4.49	419.31	17.94	419.70	7 21
440	7.70	219.84	4.92	439.21	19.69	439.65	7 42
460	8.05	229.82	5.38	459.10	21.51	459.60	8 03
480	8.40	239.80	5.86	478.98	23.42	479.55	8 24
500	8.75°	249.77	6.36	498.84	25.41	499.49	8°45′

TABLE VI.—SPIRAL FOR 4°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.2°	29.99	0.10	60.00	0.42	60.00	1°12′
80	1.6	39.99	0.19	79.99	0.74	80.00	1 36
100	2.0	49.99	0.29	99.99	1.16	99.99	2 00
120	2.4	59.98	0.42	119.98	1.68	119.99	2 24
140	2.8	69.98	0.57	139.97	2.28	139.99	2 48
160	3.2	79.98	0.74	159.95	2.98	159.98	3 12
180	3.6	89.97	0.94	179.93	3.77	179.97	3 36
200	4.0	99.96	1.16	199.90	4.65	199.96	4 00
220	4.4	109.96	1.41	219.87	5.63	219.94	4 24
240	4.8	119.95	1.67	239.83	6.70	239.93	4 48
260	5.2	129.94	1.96	259.79	7.86	259.91	5 12
280	5.6	139.93	2.28	279.73	9.12	279.88	5 36
300	6.0	149.92	2.62	299.67	10.46	299.86	6 00
320	6.4	159.90	2.98	319.60	11.90	319.82	6 24
340	6.8	169.89	3.36	339.52	13.44	339.79	6 48
360	7.2	179.87	3.77	359.44	15.06	359.75	7 12
380	7.6	189.85	4.20	379.34	16.78	379.71	7 36
400	8.0	199.83	4.65	399.23	18.59	399.66	8 00
420	8.4	209.81	5.12	419.10	20.49	419.60	8 24
440	8.8	219.79	5.62	438.97	22.49	439.54	8 48
460	9.2	229.76	6.15	458.82	24.58	459.48	9 12
480	9.6	239.73	6.69	478.66	26.76	479.41	9 36
500	10.0°	249.70	7.26	498.49	29.03	499.33	10°00′

SPIRAL FOR 4°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.35°	29.99	0.12	60.00	0.47	60.00	1°21′
80	1.80	39.99	0.21	79.99	0.84	80.00	1 48
100	2.25	49.98	0.33	99.98	1.31	99.99	2 15
120	2.70	59.98	0.47	119.97	1.88	119.99	2 42
140	3.15	69.98	0.64	139.96	2.57	139.98	3 09
160	3.60	79.97	0.84	159.94	3.35	159.97	3 36
180	4.05	89.96	1.06	179.91	4.24	179.96	4 03
200	4.50	99.95	1.31	199.88	5.23	199.95	4 30
220	4.95	109.95	1.58	219.84	6.33	219.93	4 57
240	5.40	119.93	1.88	239.79	7.54	239.91	5 24
260	5.85	129.92	2.21	259.73	8.84	259.88	5 51
280	6.30	139.91	2.56	279.66	10.25	279.85	6 18
300	6.75	149.89	2.94	299.59	11.77	299.82	6 45
320	7.20	159.88	3.35	319.50	13.39	319.78	7 12
340	7.65	169.86	3.78	339.40	15.11	339.73	7 39
360	8.10	179.84	4.23	359.29	16.94	359.68	8 06
380	8.55	189.81	4.72	379.16	18.87	379.63	8 33
400	9.00	199.79	5.23	399.02	20.91	399.57	9 00
420	9.45	209.76	5.76	418.87	23.05	419.50	9 27
440	9.90	219.73	6.32	438.70	25.29	439.42	9 54
460	10.35	229.70	6.91	458.51	27.63	459.34	10 21
480	10.80	239.66	7.53	478.31	30.08	479.25	10 48
500	11.25°	249.63	8.17	498.09	32.64	499.15	11°15′

TABLE VI.—SPIRAL FOR 5°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.5°	29.99	0.13	60.00	0.52	60.00	1°30′
80	2.0	39.99	0.23	79.99	0.93	80.00	2 00
100	2.5	49.98	0.36	99.98	1.45	99.99	2 30
120	3.0	59.98	0.52	119.97	2.09	119.99	3 00
140	3.5	69.97	0.71	139.95	2.85	139.98	3 30
160	4.0	79.96	0.93	159.92	3.72	159.97	4 00
180	4.5	89.95	1.18	179.89	4.71	179.95	4 30
200	5.0	99.94	1.45	199.85	5.81	199.93	5 00
220	5.5	109.93	1.76	219.80	7.03	219.91	5 30
240	6.0	119.92	2.09	239.74	8.37	239.88	6 00
260	6.5	129.90	2.45	259.67	9.82	259.85	6 30
280	7.0	139.89	2.85	279.58	11.39	279.82	7 00
300	7.5	149.87	3.27	299.49	13.07	299.77	7 30
320	8.0	159.85	3.72	319.38	14.87	319.73	8 00
340	8.5	169.83	4.20	339.26	16.79	339.67	8 30
360	9.0	179.80	4.70	359.12	18.82	359.61	9 00
380	9.5	189.77	5.24	378.96	20.96	379.54	9 30
400	10.0°	199.74	5.81	398.79	23.22	399.47	10°00′

SPIRAL FOR 5°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.65°	29.99	0.14	60.00	0.58	60.00	1°39′
80	2.20	39.98	0.26	79.99	1.02	79.99	2 12
100	2.75	49.98	0.40	99.98	1.60	99.99	2 45
120	3.30	59.97	0.58	119.96	2.30	119.98	3 18
140	3.85	69.96	0.78	139.94	3.13	139.97	3 51
160	4.40	79.95	1.02	159.91	4.09	159.96	4 24
180	4.95	89.94	1.29	179.87	5.18	179.94	4 57
200	5.50	99.93	1.60	199.82	6.40	199.92	5 30
220	6.05	109.92	1.93	219.76	7.74	219.89	6 03
240	6.60	119.90	2.30	239.68	9.21	239.86	6 36
260	7.15	129.89	2.70	259.60	10.80	259.82	7 09
280	7.70	139.87	3.13	279.50	12.53	279.78	7 42
300	8.25	149.84	3.59	299.38	14.38	299.73	8 15
320	8.80	159.82	4.09	319.25	16.36	319.67	8 48
340	9.35	169.79	4.61	339.10	18.46	339.60	9 21
360	9.90	179.76	5.17	358.93	20.69	359.53	9 54
380	10.45	189.72	5.76	378.74	23.05	379.45	10 27
400	11.00°	199.69	6.38	398.54	25.53	399.35	11°00′

SPIRAL FOR 6°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.8°	29.99	0.16	59.99	0.63	60.00	1°48′
80	2.4	39.98	0.28	79.99	1.12	79.99	2 24
100	3.0	49.97	0.44	99.97	1.74	99.99	3 00
120	3.6	59.96	0.63	119.95	2.51	119.98	3 36
140	4.2	69.96	0.85	139.93	3.42	139.97	4 12
160	4.8	79.95	1.12	159.89	4.47	159.95	4 48
180	5.4	89.93	1.41	179.84	5.65	179.93	5 24
200	6.0	99.92	1.74	199.78	6 98	199.90	6 00
220	6.6	109.90	2.11	219.71	8.44	219.87	6 36
240	7.2	119.88	2.51	239.62	10.04	239.83	7 12
260	7.8	129.86	2.94	259.52	11.78	259.79	7 48
280	8.4	139.84	3.41	279.40	13.66	279.74	8 24
300	9.0	149.81	3.92	299.26	15.68	299.68	9 00
320	9.6	159.78	4.46	319.11	17.84	319.61	9 36
340	10.2	169.75	5.03	338.93	20.13	339.53	10 12
360	10.8°	179.71	5.64	358.73	22.56	359.44	10°48′

TABLE VI.—SPIRAL FOR 6°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	1.95°	29.98	0.17	59.99	0.68	60.00	1°57′
80	2.60	39.98	0.30	79.98	1.21	79.99	2 36
100	3.25	49.97	0.47	99.97	1.89	99.99	3 15
120	3.90	59.96	0.68	119.94	2.72	119.98	3 54
140	4.55	69.95	0.92	139.91	3.70	139.96	4 33
160	5.20	79.94	1.21	159.87	4.84	159.94	5 12
180	5.85	89.92	1.53	179.81	6.12	179.92	5 51
200	6.50	99.91	1.89	199.74	7.56	199.89	6 30
220	7.15	109.89	2.28	219.66	9.14	219.85	7 09
240	7.80	119.86	2.72	239.56	10.88	239.80	7 48
260	8.45	129.84	3.19	259.44	12.76	259.75	8 27
280	9.10	139.81	3.70	279.30	14.80	279.69	9 06
300	9.75	149.78	4.24	299.14	16.98	299.62	9 45
320	10.40	159.75	4.83	318.95	19.32	319.54	10 24
340	11.05	169.71	5.45	338.74	21.80	339.45	11 03
360	11.70°	179.66	6.11	358.51	24.43	359.34	11°42′

SPIRAL FOR 7°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	2.1°	29.98	0.18	59.99	0.73	60.00	2°06′
80	2.8	39.97	0.33	79.98	1.30	79.99	2 48
100	3.5	49.96	0.51	99.96	2.04	99.98	3 30
120	4.2	59.95	0.73	119.94	2.93	119.97	4 12
140	4.9	69.94	1.00	139.90	3.99	139.96	4 54
160	5.6	79.93	1.30	159.85	5.21	159.93	5 36
180	6.3	89.91	1.65	179.78	6.59	179.90	6 18
200	7.0	99.89	2.03	199.70	8.14	199.87	7 00
220	7.7	109.87	2.46	219.61	9.84	219.83	7 42
240	8.4	119.84	2.92	239.49	11.71	239.77	8 24
260	9.1	129.81	3.43	259.35	13.74	259.71	9 06
280	9.8	139.78	3.98	279.19	15.93	279.64	9 48
300	10.5	149.75	4.57	299.00	18.28	299.56	10 30
320	11.2	159.70	5.20	318.79	20.79	319.46	11 12
340	11.9	169.66	5.87	338.54	23.47	339.36	11 54
360	12.6°	179.61	6.57	358.27	26.30	359.24	12°36′

SPIRAL FOR 7°30′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	2.25°	29.98	0.20	59.99	0.79	60.00	2°15′
80	3.00	39.97	0.35	79.98	1.40	79.99	3 00
100	3.75	49.96	0.54	99.96	2.18	99.98	3 45
120	4.50	59.95	0.78	119.93	3.14	119.97	4 30
140	5.25	69.93	1.07	139.88	4.27	139.95	5 15
160	6.00	79.91	1.39	159.83	5.58	159.92	6 00
180	6.75	89.90	1.76	179.75	7.06	179.89	6 45
200	7.50	99.87	2.18	199.66	8.72	199.85	7 30
220	8.25	109.85	2.63	219.55	10.54	219.80	8 15
240	9.00	119.82	3.13	239.41	12.54	239.74	9 00
260	9.75	129.79	3.68	259.25	14.72	259.67	9 45
280	10.50	139.75	4.26	279.07	17.06	279.59	10 30
300	11.25	149.71	4.89	298.85	19.58	299.49	11 15
320	12.00	159.66	5.57	318.61	22.27	319.38	12 00
340	12.75	169.61	6.28	338.33	25.13	339.26	12 45
360	13.50°	179.55	7.04	358.02	28.16	359.12	13°30′

TABLE VI.—SPIRAL FOR 8°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	2.4°	29.97	0.21	59.99	0.84	60.00	2°24′
80	3.2	39.96	0.37	79.98	1.49	79.99	3 12
100	4.0	49.95	0.58	99.95	2.33	99.98	4 00
120	4.8	59.94	0.84	119.92	3.35	119.96	4 48
140	5.6	69.92	1.14	139.87	4.56	139.94	5 36
160	6.4	79.90	1.49	159.80	5.95	159.91	6 24
180	7.2	89.88	1.88	179.72	7.53	179.88	7 12
200	8.0	99.86	2.32	199.61	9.30	199.83	8 00
220	8.8	109.83	2.81	219.48	11.24	219.77	8 48
240	9.6	119.79	3.34	239.33	13.38	239.70	9 36
260	10.4	129.76	3.92	259.15	15.69	259.62	10 24
280	11.2	139.71	4.54	278.94	18.20	279.53	11 12
300	12.0	149.67	5.22	298.69	20.88	299.42	12 00
320	12.8	159.61	5.93	318.42	23.75	319.30	12 48
340	13.6	169.55	6.70	338.10	26.79	339.16	13 36
360	14.4°	179.49	7.51	357.75	30.03	359.00	14°24′

SPIRAL FOR 9°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	c
60	2.7°	29.97	0.23	59.99	0.94	59.99	2°42′
80	3.6	39.95	0.42	79.97	1.68	79.99	3 36
100	4.5	49.94	0.65	99.94	2.62	99.97	4 30
120	5.4	59.92	0.94	119.89	3.77	119.95	5 24
140	6.3	69.90	1.28	139.83	5.13	139.93	6 18
160	7.2	79.88	1.67	159.75	6.69	159.89	7 12
180	8.1	89.85	2.11	179.64	8.47	179.84	8 06
200	9.0	99.82	2.61	199.51	10.45	199.78	9 00
220	9.9	109.78	3.16	219.35	12.64	219.71	9 54
240	10.8	119.74	3.75	239.15	15.04	239.63	10 48
260	11.7	129.69	4.40	258.92	17.65	259.52	11 42
280	12.6	139.64	5.11	278.66	20.46	279.41	12 36
300	13.5	149.58	5.86	298.35	23.47	299.27	13 30
320	14.4	159.51	6.67	318.00	26.69	319.11	14 24
340	15.3	169.44	7.53	337.60	30.11	338.94	15 18
360	16.2°	179.35	8.43	357.15	33.74	358.74	16°12′

SPIRAL FOR 10°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	3.0°	29.96	0.26	59.98	1.05	59.99	3°00′
80	4.0	39.94	0.46	79.96	1.86	79.98	4 00
100	5.0	49.92	0.72	99.92	2.91	99.97	5 00
120	6.0	59.90	1.04	119.87	4.19	119.94	6 00
140	7.0	69.88	1.42	139.79	5.70	139.91	7 00
160	8.0	79.85	1.85	159.69	7.44	159.86	8 00
180	9.0	89.81	2.35	179.56	9.41	179.81	9 00
200	10.0	99.78	2.90	199.40	11.61	199.73	10 00
220	11.0	109.73	3.50	219.20	14.04	219.64	11 00
240	12.0	119.68	4.17	238.96	16.70	239.54	12 00
260	13.0	129.62	4.89	258.67	19.59	259.41	13 00
280	14.0	139.56	5.67	278.34	22.71	279.27	14 00
300	15.0	149.48	6.51	297.96	26.05	299.10	15 00
320	16.0	159.40	7.40	317.53	29.62	318.91	16 00
340	17.0	169.31	8.35	337.04	33.42	338.69	17 00
360	18.0°	179.20	9.36	356.48	37.44	358.44	18°00′

TABLE VI.—SPIRAL FOR 12°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	3.6°	29.94	0.31	59.98	1.26	59.99	3°36′
80	4.8	39.92	0.56	79.94	2.23	79.98	4 48
100	6.0	49.89	0.87	99.89	3.49	99.95	6 00
120	7.2	59.86	1.25	119.81	5.02	119.92	7 12
140	8.4	69.82	1.70	139.70	6.83	139.87	8 24
160	9.6	79.78	2.22	159.55	8.92	159.80	9 36
180	10.8	89.73	2.81	179.37	11.28	179.72	10 48
200	12.0	99.68	3.47	199.13	13.92	199.62	12 00
220	13.2	109.61	4.19	218.84	16.83	219.49	13 12
240	14.4	119.54	4.99	238.50	20.02	239.34	14 24
260	15.6	129.46	5.85	258.09	23.47	259.16	15 36
280	16.8	139.36	6.79	277.62	27.20	278.94	16 48
300	18.0	149.25	7.79	297.07	31.20	298.70	18 00
320	19.2	159.14	8.86	316.45	35.46	318.43	19 12
340	20.4	169.00	9.99	335.74	39.99	338.11	20 24
360	21.6°	178.86	11.20	354.95	44.79	357.76	21°36′

SPIRAL FOR 14°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	4.2°	29.92	0.36	59.97	1.47	59.99	4°12′
80	5.6	39.89	0.65	79.92	2.60	79.97	5 36
100	7.0	49.85	1.01	99.85	4.07	99.93	7 00
120	8.4	59.81	1.45	119.74	5.86	119.89	8 24
140	9.8	69.76	1.98	139.59	7.97	139.82	9 48
160	11.2	79.70	2.58	159.39	10.40	159.73	11 12
180	12.6	89.64	3.27	179.14	13.15	179.62	12 36
200	14.0	99.56	4.03	198.82	16.22	199.48	14 00
220	15.4	109.47	4.88	218.42	19.61	219.30	15 24
240	16.8	119.37	5.80	237.96	23.32	239.10	16 48
260	18.2	129.26	6.81	257.40	27.33	258.85	18 12
280	19.6	139.13	7.89	276.76	31.67	278.56	19 36
300	21.0	148.99	9.06	296.02	36.31	298.24	21 00
320	22.4	158.83	10.30	315.17	41.25	317.86	22 24
340	23.8	168.65	11.62	334.21	46.51	337.43	23 48
360	25.2°	178.45	13.02	353.14	52.06	356.95	25°12′

SPIRAL FOR 15°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	4.5°	29.91	0.39	59.96	1.57	59.98	4°30′
80	6.0	39.87	0.69	79.91	2.79	79.96	6 00
100	7.5	49.83	1.08	99.83	4.36	99.92	7 30
120	9.0	59.78	1.56	119.71	6.27	119.87	9°00′
140	10.5	69.73	2.12	139.53	8.53	139.79	10 30
160	12.0	79.66	2.76	159.30	11.14	159.69	12 00
180	13.5	89.58	3.50	179.01	14.08	179.56	13 30
200	15.0	99.50	4.32	198.64	17.37	199.40	15 00
220	16.5	109.40	5.22	218.19	21.00	219.20	16 30
240	18.0	119.28	6.21	237.66	24.96	238.96	18 00
260	19.5	129.15	7.28	257.02	29.26	258.68	19 30
280	21.0	139.00	8.44	276.28	33.89	278.35	21 00
300	22.5	148.84	9.69	295.43	38.84	297.97	22 30
320	24.0	158.65	11.01	314.46	44.13	317.54	24 00
340	25.5	168.45	12.42	333.36	49.74	337.05	25 30
360	27.0°	178.22	13.92	352.13	55.67	356.50	27°00′

TABLE VI.—SPIRAL FOR 16°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	4.8°	29.90	0.41	59.96	1.67	59.98	4°48′
80	6.4	39.85	0.74	79.90	2.98	79.96	6 24
100	8.0	49.81	1.15	99.81	4.65	99.91	8 00
120	9.6	59.75	1.66	119.67	6.69	119.85	9 36
140	11.2	69.69	2.26	139.47	9.10	139.77	11 12
160	12.8	79.61	2.95	149.21	11.87	159.65	12 48
180	14.4	89.53	3.73	178.87	15.01	179.50	14 24
200	16.0	99.43	4.60	198.45	18.51	199.32	16 00
220	17.6	109.31	5.56	217.94	22.38	219.09	17 36
240	19.2	119.18	6.61	237.33	26.60	238.82	19 12
260	20.8	129.04	7.76	256.61	31.17	258.50	20 48
280	22.4	138.87	8.99	275.77	36.10	278.13	22 24
300	24.0	148.68	10.31	294.81	41.37	297.70	24 00
320	25.6	158.47	11.72	313.70	46.99	317.20	25 36
340	27.2	168.24	13.23	332.46	52.95	336.65	27 12
360	28.8°	177.98	14.81	351.06	59.25	356.02	28°48′

SPIRAL FOR 18°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	5.4°	29.87	0.47	59.95	1.88	59.98	5°24′
80	7.2	39.82	0.83	79.87	3.35	79.94	7 12
100	9.0	49.75	1.29	99.75	5.23	99.89	9 00
120	10.8	59.69	1.86	119.58	7.52	119.81	10 48
140	12.6	69.60	2.53	139.33	10.23	139.70	12 36
160	14.4	79.51	3.30	159.00	13.34	159.56	14 24
180	16.2	89.40	4.18	178.57	16.87	179.37	16 12
200	18.0	99.28	5.16	198.05	20.80	199.14	18 00
220	19.8	109.13	6.23	217.40	25.13	218.85	19 48
240	21.6	118.97	7.41	236.63	29.86	238.51	21 36
260	23.4	128.78	8.69	255.72	34.98	258.10	23 24
280	25.2	138.57	10.07	274.66	40.49	277.63	25 12
300	27.0	148.34	11.55	293.44	46.39	297.09	27 00
320	28.8	158.07	13.13	312.05	52.67	316.47	28 48
340	30.6	167.78	14.81	330.48	59.32	335.76	30 36
360	32.4°	177.45	16.59	348.72	66.34	354.97	32°24′

SPIRAL FOR 20°00′ CURVE

l_c	s_c	q	p	y_c	x_c	C	s_c
60	6.0°	29.84	0.52	59.93	2.09	59.97	6°00′
80	8.0	39.77	0.92	79.85	3.72	79.93	8 00
100	10.0	49.70	1.43	99.70	5.81	99.87	10 00
120	12.0	59.61	2.06	119.48	8.35	119.77	12 00
140	14.0	69.51	2.80	139.17	11.35	139.63	14 00
160	16.0	79.40	3.66	158.76	14.81	159.45	16 00
180	18.0	89.26	4.63	178.24	18.72	179.22	18 00
200	20.0	99.11	5.71	197.59	23.07	198.93	20 00
220	22.0	108.93	6.90	216.80	27.87	218.58	22 00
240	24.0	118.73	8.20	235.85	33.10	238.16	24 00
260	26.0	128.50	9.62	254.73	38.76	257.66	26 00
280	28.0	138.24	11.15	273.42	44.85	277.08	28 00
300	30.0	147.95	12.78	291.92	51.36	296.41	30 00
320	32.0	157.63	14.52	310.21	58.28	315.64	32 00
340	34.0	167.27	16.38	328.28	65.60	334.77	34 00
360	36.0°	176.87	18.34	346.12	73.33	353.80	36°00′

TABLE VII. — DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

Sc	1	2	3	4	5	6	7	8	9	10
0.0°	0°00.00′	0°00.0′	0°00.0′	0°00.0′	0°00.0′	0°00.0′	0°00.0′	0°00.0′	0°00.0′	0°00.0′
.1	00.02	00.1	00.2	00.3	00.5	00.7	01.0	01.3	01.6	02.0
.2	00.04	00.2	00.4	00.6	01.0	01.4	02.0	02.6	03.2	04.0
.3	00.06	00.2	00.5	01.0	01.5	02.2	02.9	03.8	04.9	06.0
.4	00.08	00.3	00.7	01.3	02.0	02.9	03.9	05.1	06.5	08.0
0.5	0 00.10	0 00.4	0 00.9	0 01.6	0 02.5	0 03.6	0 04.9	0 06.4	0 08.1	0 10.0
.6	00.12	00.5	01.1	01.9	03.0	04.3	05.9	07.7	09.7	12.0
.7	00.14	00.6	01.3	02.2	03.5	05.0	06.9	09.0	11.3	14.0
.8	00.16	00.6	01.4	02.6	04.0	05.8	07.8	10.2	13.0	16.0
.9	00.18	00.7	01.6	02.9	04.5	06.5	08.8	11.5	14.6	18.0
1.0	0 00.20	0 00.8	0 01.8	0 03.2	0 05.0	0 07.2	0 09.8	0 12.8	0 16.2	0 20.0
.1	00.22	00.9	02.0	03.5	05.5	07.9	10.8	14.1	17.8	22.0
.2	00.24	01.0	02.2	03.8	06.0	08.6	11.8	15.4	19.4	24.0
.3	00.26	01.0	02.3	04.2	06.5	09.4	12.7	16.6	21.1	26.0
.4	00.28	01.1	02.5	04.5	07.0	10.1	13.7	17.9	22.7	28.0
1.5	0 00.30	0 01.2	0 02.7	0 04.8	0 07.5	0 10.8	0 14.7	0 19.2	0 24.3	0 30.0
.6	00.32	01.3	02.9	05.1	08.0	11.5	15.7	20.5	25.9	32.0
.7	00.34	01.4	03.1	05.4	08.5	12.2	16.7	21.8	27.5	34.0
.8	00.36	01.4	03.2	05.8	09.0	13.0	17.6	23.0	29.2	36.0
.9	00.38	01.5	03.4	06.1	09.5	13.7	18.6	24.3	30.8	38.0
2.0	0 00.40	0 01.6	0 03.6	0 06.4	0 10.0	0 14.4	0 19.6	0 25.6	0 32.4	0 40.0
.1	00.42	01.7	03.8	06.7	10.5	15.1	20.6	26.9	34.0	42.0
.2	00.44	01.8	04.0	07.0	11.0	15.8	21.6	28.2	35.6	44.0
.3	00.46	01.8	04.1	07.4	11.5	16.6	22.5	29.4	37.3	46.0
.4	00.48	01.9	04.3	07.7	12.0	17.3	23.5	30.7	38.9	48.0
2.5	0 00.50	0 02.0	0 04.5	0 08.0	0 12.5	0 18.0	0 24.5	0 32.0	0 40.5	0 50.0
.6	00.52	02.1	04.7	08.3	13.0	18.7	25.5	33.3	42.1	52.0
.7	00.54	02.2	04.9	08.6	13.5	19.4	26.5	34.6	43.7	54.0
.8	00.56	02.2	05.0	09.0	14.0	20.2	27.4	35.8	45.4	56.0
.9	00.58	02.3	05.2	09.3	14.5	20.9	28.4	37.1	47.0	58.0
3.0	0 00.60	0 02.4	0 05.4	0 09.6	0 15.0	0 21.6	0 29.4	0 38.4	0 48.6	1 00.0
.1	00.62	02.5	05.6	09.9	15.5	22.3	30.4	39.7	50.2	02.0
.2	00.64	02.6	05.8	10.2	16.0	23.0	31.4	41.0	51.8	04.0
.3	00.66	02.6	05.9	10.6	16.5	23.8	32.3	42.2	53.5	06.0
.4	00.68	02.7	06.1	10.9	17.0	24.5	33.3	43.5	55.1	08.0
3.5	0 00.70	0 02.8	0 06.3	0 11.2	0 17.5	0 25.2	0 34.3	0 44.8	0 56.7	1 10.0
.6	00.72	02.9	06.5	11.5	18.0	25.9	35.3	46.1	58.3	12.0
.7	00.74	03.0	06.7	11.8	18.5	26.6	36.3	47.4	59.9	14.0
.8	00.76	03.0	06.8	12.2	19.0	27.4	37.2	48.6	1 01.6	16.0
.9	00.78	03.1	07.0	12.5	19.5	28.1	38.2	49.9	03.2	18.0
4.0	0 00.80	0 03.2	0 07.2	0 12.8	0 20.0	0 28.8	0 39.2	0 51.2	1 04.8	1 20.0
.1	00.82	03.3	07.4	13.1	20.5	29.5	40.2	52.5	06.4	22.0
.2	00.84	03.4	07.6	13.4	21.0	30.2	41.2	53.8	08.0	24.0
.3	00.86	03.4	07.7	13.8	21.5	31.0	42.1	55.0	09.7	26.0
.4	00.88	03.5	07.9	14.1	22.0	31.7	43.1	56.3	11.3	28.0
4.5	0 00.90	0 03.6	0 08.1	0 14.4	0 22.5	0 32.4	0 44.1	0 57.6	1 12.9	1 30.0
.6	00.92	03.7	08.3	14.7	23.0	33.1	45.1	58.9	14.5	32.0
.7	00.94	03.8	08.5	15.0	23.5	33.8	46.1	1 00.2	16.1	34.0
.8	00.96	03.8	08.6	15.4	24.0	34.6	47.0	01.4	17.8	36.0
.9	00.98	03.9	08.8	15.7	24.5	35.3	48.0	02.7	19.4	38.0
5.0	0 01.00	0 04.0	0 09.0	0 16.0	0 25.0	0 36.0	0 49.0	1 04.0	1 21.0	1 40.0
.1	01.02	04.1	09.2	16.3	25.5	36.7	50.0	05.3	22.6	42.0
.2	01.04	04.2	09.4	16.6	26.0	37.4	51.0	06.6	24.2	44.0
.3	01.06	04.2	09.5	17.0	26.5	38.2	51.9	07.8	25.9	46.0
.4	01.08	04.3	09.7	17.3	27.0	38.9	52.9	09.1	27.5	48.0
5.5	0 01.10	0 04.4	0 09.9	0 17.6	0 27.5	0 39.6	0 53.9	1 10.4	1 29.1	1 50.0
.6	01.12	04.5	10.1	17.9	28.0	40.3	54.9	11.7	30.7	52.0
.7	01.14	04.6	10.3	18.2	28.5	41.0	55.9	13.0	32.3	54.0
.8	01.16	04.6	10.4	18.6	29.0	41.8	56.8	14.2	34.0	56.0
.9	01.18	04.7	10.6	18.9	29.5	42.5	57.8	15.5	35.6	58.0
6.0	0 01.20	0 04.8	0 10.8	0 19.2	0 30.0	0 43.2	0 58.8	1 16.8	1 37.2	2 00.0
	1	2	3	4	5	6	7	8	9	10

TABLE VII. — DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

S_c	1	2	3	4	5	6	7	8	9	10
6.0°	0°01.20′	0°04.8′	0°10.8′	0°19.2′	0°30.0′	0°43.2′	0°58.8′	1°16.8′	1°37.2′	2°00.0′
.1	01.22	04.9	11.0	19.5	30.5	43.9	59.8	18.1	38.8	02.0
.2	01.24	05.0	11.2	19.8	31.0	44.6	1 00.8	19.4	40.4	04.0
.3	01.26	05.0	11.3	20.2	31.5	45.4	01.7	20.6	42.1	06.0
.4	01.28	05.1	11.5	20.5	32.0	46.1	02.7	21.9	43.7	08.0
.5	0 01.30	0 05.2	0 11.7	0 20.8	0 32.5	0 46.8	1 03.7	1 23.2	1 45.3	2 10.0
.6	01.32	05.3	11.9	21.1	33.0	47.5	04.7	24.5	46.9	12.0
.7	01.34	05.4	12.1	21.4	33.5	48.2	05.7	25.8	48.5	14.0
.8	01.36	05.4	12.2	21.8	34.0	49.0	06.6	27.0	50.2	16.0
.9	01.38	05.5	12.4	22.1	34.5	49.7	07.6	28.3	51.8	18.0
7.0	0 01.40	0 05.6	0 12.6	0 22.4	0 35.0	0 50.4	1 08.6	1 29.6	1 53.4	2 20.0
.1	01.42	05.7	12.8	22.7	35.5	51.1	09.6	30.9	55.0	22.0
.2	01.44	05.8	13.0	23.0	36.0	51.8	10.6	32.2	56.6	24.0
.3	01.46	05.8	13.1	23.4	36.5	52.6	11.5	33.4	58.3	26.0
.4	01.48	05.9	13.3	23.7	37.0	53.3	12.5	34.7	59.9	28.0
.5	0 01.50	0 06.0	0 13.5	0 24.0	0 37.5	0 54.0	1 13.5	1 36.0	2 01.5	2 30.0
.6	01.52	06.1	13.7	24.3	38.0	54.7	14.5	37.3	03.1	32.0
.7	01.54	06.2	13.9	24.6	38.5	55.4	15.5	38.6	04.7	34.0
.8	01.56	06.2	14.0	25.0	39.0	56.2	16.4	39.8	06.4	36.0
.9	01.58	06.3	14.2	25.3	39.5	56.9	17.4	41.1	08.0	38.0
8.0	0 01.60	0 06.4	0 14.4	0 25.6	0 40.0	0 57.6	1 18.4	1 42.4	2 09.6	2 40.0
.1	01.62	06.5	14.6	25.9	40.5	58.3	19.4	43.7	11.2	42.0
.2	01.64	06.6	14.8	26.2	41.0	59.0	20.4	45.0	12.8	44.0
.3	01.66	06.6	14.9	26.6	41.5	59.8	21.3	46.2	14.5	46.0
.4	01.68	06.7	15.1	26.9	42.0	1 00.5	22.3	47.5	16.1	48.0
.5	0 01.70	0 06.8	0 15.3	0 27.2	0 42.5	1 01.2	1 23.3	1 48.8	2 17.7	2 50.0
.6	01.72	06.9	15.5	27.5	43.0	01.9	24.3	50.1	19.3	52.0
.7	01.74	07.0	15.7	27.8	43.5	02.6	25.3	51.4	20.9	54.0
.8	01.76	07.0	15.8	28.2	44.0	03.4	26.2	52.6	22.6	56.0
.9	01.78	07.1	16.0	28.5	44.5	04.1	27.2	53.9	24.2	58.0
9.0	0 01.80	0 07.2	0 16.2	0 28.8	0 45.0	1 04.8	1 28.2	1 55.2	2 25.8	3 00.0
.1	01.82	07.3	16.4	29.1	45.5	05.5	29.2	56.5	27.4	02.0
.2	01.84	07.4	16.6	29.4	46.0	06.2	30.2	57.8	29.0	04.0
.3	01.86	07.4	16.7	29.8	46.5	07.0	31.1	59.0	30.7	06.0
.4	01.88	07.5	16.9	30.1	47.0	07.7	32.1	2 00.3	32.3	08.0
.5	0 01.90	0 07.6	0 17.1	0 30.4	0 47.5	1 08.4	1 33.1	2 01.6	2 33.9	3 10.0
.6	01.92	07.7	17.3	30.7	48.0	09.1	34.1	02.9	35.5	12.0
.7	01.94	07.8	17.5	31.0	48.5	09.8	35.1	04.2	37.1	14.0
.8	01.96	07.8	17.6	31.4	49.0	10.6	36.0	05.4	38.8	16.0
.9	01.98	07.9	17.8	31.7	49.5	11.3	37.0	06.7	40.4	18.0
10.0	0 02.00	0 08.0	0 18.0	0 32.0	0 50.0	1 12.0	1 38.0	2 08.0	2 42.0	3 20.0
.1	02.02	08.1	18.2	32.3	50.5	12.7	39.0	09.3	43.6	21.9
.2	02.04	08.2	18.4	32.6	51.0	13.4	40.0	10.6	45.2	23.9
.3	02.06	08.2	18.5	33.0	51.5	14.2	40.9	11.8	46.8	25.9
.4	02.08	08.3	18.7	33.3	52.0	14.9	41.9	13.1	48.5	27.9
.5	0 02.10	0 08.4	0 18.9	0 33.6	0 52.5	1 15.6	1 42.9	2 14.4	2 50.1	3 29.9
.6	02.12	08.5	19.1	33.9	53.0	16.3	43.9	15.7	51.7	31.9
.7	02.14	08.6	19.3	34.2	53.5	17.0	44.9	17.0	53.3	33.9
.8	02.16	08.6	19.4	34.6	54.0	17.8	45.8	18.2	54.9	35.9
.9	02.18	08.7	19.6	34.9	54.5	18.5	46.8	19.5	56.6	37.9
11.0	0 02.20	0 08.8	0 19.8	0 35.2	0 55.0	1 19.2	1 47.8	2 20.8	2 58.2	3 39.9
.1	02.22	08.9	20.0	35.5	55.5	19.9	48.8	22.1	59.8	41.9
.2	02.24	09.0	20.2	35.8	56.0	20.6	49.8	23.4	3 01.4	43.9
.3	02.26	09.0	20.3	36.2	56.5	21.4	50.7	24.6	03.0	45.9
.4	02.28	09.1	20.5	36.5	57.0	22.1	51.7	25.9	04.7	47.9
.5	0 02.30	0 09.2	0 20.7	0 36.8	0 57.5	1 22.8	1 52.7	2 27.2	3 06.3	3 49.9
.6	02.32	09.3	20.9	37.1	58.0	23.5	53.7	28.5	07.9	51.9
.7	02.34	09.4	21.1	37.4	58.5	24.2	54.7	29.7	09.5	53.9
.8	02.36	09.4	21.2	37.8	59.0	25.0	55.6	31.0	11.1	55.9
.9	02.38	09.5	21.4	38.1	59.5	25.7	56.6	32.3	12.7	57.9
12.0	0 02.40	0 09.6	0 21.6	0 38.4	1 00.0	1 26.4	1 57.6	2 33.6	3 14.4	3 59.9
	1	2	3	4	5	6	7	8	9	10

TABLE VII. — DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

S_c	1	2	3	4	5	6	7	8	9	10
12.0°	0°02.40′	0°09.6′	0°21.6′	0°38.4′	1°00.0′	1°26.4′	1°57.6′	2°33.6′	3°14.4′	3°59.9′
.1	02.42	09.7	21.8	38.7	00.5	27.1	58.6	34.9	16.0	4 01.9
.2	02.44	09.8	22.0	39.0	01.0	27.8	59.5	36.1	17.6	03.9
.3	02.46	09.8	22.1	39.4	01.5	28.6	2 00.5	37.4	19.2	05.9
.4	02.48	09.9	22.3	39.7	02.0	29.3	01.5	38.7	20.8	07.9
.5	0 02.50	0 10.0	0 22.5	0 40.0	1 02.5	1 30.0	2 02.5	2 40.0	3 22.5	4 09.9
.6	02.52	10.1	22.7	40.3	03.0	30.7	03.5	41.3	24.1	11.9
.7	02.54	10.2	22.9	40.6	03.5	31.4	04.4	42.5	25.7	13.9
.8	02.56	10.2	23.0	41.0	04.0	32.2	05.4	43.8	27.3	15.9
.9	02.58	10.3	23.2	41.3	04.5	32.9	06.4	45.1	28.9	17.9
13.0	0 02.60	0 10.4	0 23.4	0 41.6	1 05.0	1 33.6	2 07.4	2 46.4	3 30.5	4 19.9
.1	02.62	10.5	23.6	41.9	05.5	34.3	08.4	47.7	32.2	21.9
.2	02.64	10.6	23.8	42.2	06.0	35.0	09.3	48.9	33.8	23.9
.3	02.66	10.6	23.9	42.6	06.5	35.8	10.3	50.2	35.4	25.9
.4	02.68	10.7	24.1	42.9	07.0	36.5	11.3	51.5	37.0	27.9
.5	0 02.70	0 10.8	0 24.3	0 43.2	1 07.5	1 37.2	2 12.3	2 52.8	3 38.6	4 29.9
.6	02.72	10.9	24.5	43.5	08.0	37.9	13.3	54.0	40.3	31.9
.7	02.74	11.0	24.7	43.8	08.5	38.6	14.2	55.3	41.9	33.9
.8	02.76	11.0	24.8	44.2	09.0	39.4	15.2	56.6	43.5	35.9
.9	02.78	11.1	25.0	44.5	09.5	40.1	16.2	57.9	45.1	37.9
14.0	0 02.80	0 11.2	0 25.2	0 44.8	1 10.0	1 40.8	2 17.2	2 59.2	3 46.7	4 39.9
.1	02.82	11.3	25.4	45.1	10.5	41.5	18.2	3 00.4	48.4	41.9
.2	02.84	11.4	25.6	45.4	11.0	42.2	19.1	01.7	50.0	43.9
.3	02.86	11.4	25.7	45.8	11.5	43.0	20.1	03.0	51.6	45.9
.4	02.88	11.5	25.9	46.1	12.0	43.7	21.1	04.3	53.2	47.9
.5	0 02.90	0 11.6	0 26.1	0 46.4	1 12.5	1 44.4	2 22.1	3 05.6	3 54.8	4 49.9
.6	02.92	11.7	26.3	46.7	13.0	45.1	23.1	06.8	56.4	51.9
.7	02.94	11.8	26.5	47.0	13.5	45.8	24.0	08.1	58.1	53.9
.8	02.96	11.8	26.6	47.4	14.0	46.6	25.0	09.4	59.7	55.8
.9	02.98	11.9	26.8	47.7	14.5	47.3	26.0	10.7	4 01.3	57.8
15.0	0 03.00	0 12.0	0 27.0	0 48.0	1 15.0	1 48.0	2 27.0	3 12.0	4 02.9	4 59.8
.1	03.02	12.1	27.2	48.3	15.5	48.7	28.0	13.2	04.5	5 01.8
.2	03.04	12.2	27.4	48.6	16.0	49.4	28.9	14.5	06.1	03.8
.3	03.06	12.2	27.5	49.0	16.5	50.2	29.9	15.8	07.8	05.8
.4	03.08	12.3	27.7	49.3	17.0	50.9	30.9	17.1	09.4	07.8
.5	0 03.10	0 12.4	0 27.9	0 49.6	1 17.5	1 51.6	2 31.9	3 18.4	4 11.0	5 09.8
.6	03.12	12.5	28.1	49.9	18.0	52.3	32.9	19.6	12.6	11.8
.7	03.14	12.6	28.3	50.2	18.5	53.0	33.8	20.9	14.2	13.8
.8	03.16	12.6	28.4	50.6	19.0	53.7	34.8	22.2	15.9	15.8
.9	03.18	12.7	28.6	50.9	19.5	54.5	35.8	23.5	17.5	17.8
16.0	0 03.20	0 12.8	0 28.8	0 51.2	1 20.0	1 55.2	2 36.8	3 24.8	4 19.1	5 19.8
.1	03.22	12.9	29.0	51.5	20.5	55.9	37.8	26.0	20.7	21.8
.2	03.24	13.0	29.2	51.8	21.0	56.6	38.7	27.3	22.3	23.8
.3	03.26	13.0	29.3	52.2	21.5	57.3	39.7	28.6	23.9	25.8
.4	03.28	13.1	29.5	52.5	22.0	58.1	40.7	29.9	25.6	27.8
.5	0 03.30	0 13.2	0 29.7	0 52.8	1 22.5	1 58.8	2 41.7	3 31.1	4 27.2	5 29.8
.6	03.32	13.3	29.9	53.1	23.0	59.5	42.7	32.4	28.8	31.8
.7	03.34	13.4	30.1	53.4	23.5	2 00.2	43.6	33.7	30.4	33.8
.8	03.36	13.4	30.2	53.8	24.0	00.9	44.6	35.0	32.0	35.8
.9	03.38	13.5	30.4	54.1	24.5	01.7	45.6	36.3	33.6	37.8
17.0	0 03.40	0 13.6	0 30.6	0 54.4	1 25.0	2 02.4	2 46.6	3 37.5	4 35.3	5 39.8
.1	03.42	13.7	30.8	54.7	25.5	03.1	47.5	38.8	36.9	41.8
.2	03.44	13.8	31.0	55.0	26.0	03.8	48.5	40.1	38.5	43.7
.3	03.46	13.8	31.1	55.4	26.5	04.5	49.5	41.4	40.1	45.7
.4	03.48	13.9	31.3	55.7	27.0	05.3	50.5	42.7	41.7	47.7
.5	0 03.50	0 14.0	0 31.5	0 56.0	1 27.5	2 06.0	2 51.5	3 43.9	4 43.4	5 49.7
.6	03.52	14.1	31.7	56.3	28.0	06.7	52.4	45.2	45.0	51.7
.7	03.54	14.2	31.9	56.6	28.5	07.4	53.4	46.5	46.6	53.7
.8	03.56	14.2	32.0	57.0	29.0	08.1	54.4	47.8	48.2	55.7
.9	03.58	14.3	32.2	57.3	29.5	08.9	55.4	49.0	49.8	57.7
18.0	0 03.60	0 14.4	0 32.4	0 57.6	1 30.0	2 09.6	2 56.4	3 50.3	4 51.5	5 59.7
	1	2	3	4	5	6	7	8	9	10

TABLE VII. — DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

		2	3	4	5	6	7	8	9	10
18.0°	0°03.60′	0°14.4′	0°32.4′	0°57.6′	1°30.0′	2°09.6′	2°56.4′	3°50.3′	4°51.5′	5°59.7′
.1	03.62	14.5	32.6	57.9	30.5	10.3	57.3	51.6	53.1	6 01.7
.2	03.64	14.6	32.8	58.2	31.0	11.0	58.3	52.9	54.7	03.7
.3	03.66	14.6	32.9	58.6	31.5	11.7	59.3	54.2	56.3	05.7
.4	03.68	14.7	33.1	58.9	32.0	12.5	3 00.3	55.4	57.9	07.7
.5	0 03.70	0 14.8	0 33.3	0 59.2	1 32.5	2 13.2	3 01.3	3 56.7	4 59.5	6 09.7
.6	03.72	14.9	33.5	59.5	33.0	13.9	02.2	58.0	5 01.2	11.7
.7	03.74	15.0	33.7	59.8	33.5	14.6	03.2	59.3	02.8	13.7
.8	03.76	15.0	33.8	1 00.2	34.0	15.3	04.2	4 00.6	04.4	15.7
.9	03.78	15.1	34.0	00.5	34.5	16.1	05.2	01.8	06.0	17.7
19.0	0 03.80	0 15.2	0 34.2	1 00.8	1 35.0	2 16.8	3 06.2	4 03.1	5 07.6	6 19.7
.1	03.82	15.3	34.4	01.1	35.5	17.5	07.1	04.4	09.2	21.7
.2	03.84	15.4	34.6	01.4	36.0	18.2	08.1	05.7	10.9	23.7
.3	03.86	15.4	34.7	01.8	36.5	18.9	09.1	06.9	12.5	25.6
.4	03.88	15.5	34.9	02.1	37.0	19.7	10.1	08.2	14.1	27.6
.5	0 03.90	0 15.6	0 35.1	1 02.4	1 37.5	2 20.4	3 11.1	4 09.5	5 15.7	6 29.6
.6	03.92	15.7	35.3	02.7	38.0	21.1	12.0	10.8	17.3	31.6
.7	03.94	15.8	35.5	03.0	38.5	21.8	13.0	12.1	18.9	33.6
.8	03.96	15.8	35.6	03.4	39.0	22.5	14.0	13.3	20.6	35.6
.9	03.98	15.9	35.8	03.7	39.5	23.3	15.0	14.6	22.2	37.6
20.0	0 04.00	0 16.0	0 36.0	1 04.0	1 40.0	2 24.0	3 16.0	4 15.9	5 23.8	6 39.6
.1	04.02	16.1	36.2	04.3	40.5	24.7	16.9	17.2	25.4	41.6
.2	04.04	16.2	36.4	04.6	41.0	25.4	17.9	18.5	27.0	43.6
.3	04.06	16.2	36.5	05.0	41.5	26.1	18.9	19.7	28.6	45.6
.4	04.08	16.3	36.7	05.3	42.0	26.9	19.9	21.0	30.3	47.6
.5	0 04.10	0 16.4	0 36.9	1 05.6	1 42.5	2 27.6	3 20.9	4 22.3	5 31.9	6 49.6
.6	04.12	16.5	37.1	05.9	43.0	28.3	21.8	23.6	33.5	51.6
.7	04.14	16.6	37.3	06.2	43.5	29.0	22.8	24.8	35.1	53.6
.8	04.16	16.6	37.4	06.6	44.0	29.7	23.8	26.1	36.7	55.6
.9	04.18	16.7	37.6	06.9	44.5	30.5	24.8	27.4	38.3	57.5
21.0	0 04.20	0 16.8	0 37.8	1 07.2	1 45.0	2 31.2	3 25.8	4 28.7	5 40.0	6 59.5
.2	04.24	17.0	38.2	07.8	46.0	32.6	27.7	31.2	43.2	7 03.5
.4	04.28	17.1	38.5	08.5	47.0	34.1	29.7	33.8	46.4	07.5
.6	04.32	17.3	38.9	09.1	48.0	35.5	31.6	36.4	49.7	11.5
.8	04.36	17.4	39.2	09.8	49.0	37.0	33.6	38.9	52.9	15.5
22.0	0 04.40	0 17.6	0 39.6	1 10.4	1 50.0	2 38.4	3 35.5	4 41.5	5 56.1	7 19.5
.2	04.44	17.8	40.0	11.0	51.0	39.8	37.5	44.0	59.3	23.5
.4	04.48	17.9	40.3	11.7	52.0	41.3	39.5	46.6	6 02.6	27.5
.6	04.52	18.1	40.7	12.3	53.0	42.7	41.4	49.1	05.8	31.4
.8	04.56	18.2	41.0	13.0	54.0	44.2	43.4	51.7	09.0	35.4
23.0	0 04.60	0 18.4	0 41.4	1 13.6	1 55.0	2 45.6	3 45.3	4 54.2	6 12.3	7 39.4
.2	04.64	18.6	41.8	14.2	56.0	47.0	47.3	56.8	15.5	43.4
.4	04.68	18.7	42.1	14.9	57.0	48.5	49.2	59.4	18.7	47.4
.6	04.72	18.9	42.5	15.5	58.0	49.9	51.2	5 01.9	22.0	51.4
.8	04.76	19.0	42.8	16.2	59.0	51.4	53.2	04.5	25.2	55.3
24.0	0 04.80	0 19.2	0 43.2	1 16.8	2 00.0	2 52.8	3 55.1	5 07.0	6 28.4	7 59.1
.2	04.84	19.4	43.6	17.4	01.0	54.2	57.1	09.6	31.7	8 03.3
.4	04.88	19.5	43.9	18.1	02.0	55.7	59.0	12.1	34.9	07.3
.6	04.92	19.7	44.3	18.7	03.0	57.1	4 01.0	14.7	38.1	11.3
.8	04.96	19.8	44.6	19.4	04.0	58.6	03.0	17.2	41.3	15.3
25.0	0 05.00	0 20.0	0 45.0	1 20.0	2 05.0	3 00.0	4 04.9	5 19.8	6 44.6	8 19.2
.2	05.04	20.2	45.4	20.6	06.0	01.4	06.9	22.4	47.8	23.2
.4	05.08	20.3	45.7	21.3	07.0	02.9	08.8	24.9	51.0	27.2
.6	05.12	20.5	46.1	21.9	08.0	04.3	10.8	27.5	54.3	31.2
.8	05.16	20.6	46.4	22.6	09.0	05.8	12.8	30.0	57.5	35.2
26.0	0 05.20	0 20.8	0 46.8	1 23.2	2 10.0	3 07.2	4 14.7	5 32.6	7 00.7	8 39.1
.2	05.24	21.0	47.2	23.8	11.0	08.6	16.7	35.1	04.0	43.1
.4	05.28	21.1	47.5	24.5	12.0	10.1	18.6	37.7	07.2	47.1
.6	05.32	21.3	47.9	25.1	13.0	11.5	20.6	40.2	10.4	51.1
.8	05.36	21.4	48.2	25.8	14.0	13.0	22.5	42.8	13.7	55.1
27.0	0 05.40	0 21.6	0 48.6	1 26.4	2 15.0	3 14.4	4 24.5	5 45.4	7 16.9	8 59.0
				4	5	6	7	8	9	10

S_c	1	2	3	4	5	6	7	8	9	10
27.0°	0°05.40′	0°21.6′	0°48.6′	1°26.4′	2°15.0′	3°14.4′	4°24.5′	5°45.4′	7°16.9′	8°59.0′
.2	05.44	21.8	49.0	27.0	16.0	15.8	26.5	47.9	20.1	9 03.0
.4	05.48	21.9	49.3	27.7	17.0	17.3	28.4	50.5	23.3	07.0
.6	05.52	22.1	49.7	28.3	18.0	18.7	30.4	53.0	26.6	11.0
.8	05.56	22.2	50.0	29.0	19.0	20.1	32.3	55.6	29.8	14.9
28.0	0 05.60	0 22.4	0 50.4	1 29.6	2 20.0	3 21.5	4 34.3	5 58.1	7 33.0	9 18.9
.2	05.64	22.6	50.8	30.2	21.0	23.0	36.2	6 00.7	36.3	22.9
.4	05.68	22.7	51.1	30.9	22.0	24.4	38.2	03.2	39.5	26.9
.6	05.72	22.9	51.5	31.5	23.0	25.9	40.2	05.8	42.7	30.9
.8	05.76	23.0	51.8	32.2	24.0	27.3	42.1	08.3	45.9	34.8
29.0	0 05.80	0 23.2	0 52.2	1 32.8	2 25.0	3 28.8	4 44.1	6 10.9	7 49.2	9 38.8
.2	05.84	23.4	52.6	33.4	26.0	30.2	46.0	13.4	52.4	42.8
.4	05.88	23.5	52.9	34.1	27.0	31.6	48.0	16.0	55.6	46.8
.6	05.92	23.7	53.3	34.7	28.0	33.1	49.9	18.6	58.8	50.7
.8	05.96	23.8	53.6	35.4	29.0	34.5	51.9	21.1	8 02.1	54.7
30.0	0 06.00	0 24.0	0 54.0	1 36.0	2 30.0	3 35.9	4 53.9	6 23.7	8 05.3	9 58.7
.2	06.04	24.2	54.4	36.6	31.0	37.4	55.8	26.2	08.5	10 02.6
.4	06.08	24.3	54.7	37.3	32.0	38.8	57.8	28.8	11.7	06.6
.6	06.12	24.5	55.1	37.9	33.0	40.3	59.7	31.3	15.0	10.6
.8	06.16	24.6	55.4	38.6	34.0	41.7	5 01.7	33.9	18.2	14.6
31.0	0 06.20	0 24.8	0 55.8	1 39.2	2 35.0	3 43.1	5 03.6	6 36.4	8 21.4	10 18.5
.2	06.24	25.0	56.2	39.8	36.0	44.6	05.6	39.0	24.6	22.5
.4	06.28	25.1	56.5	40.5	37.0	46.0	07.5	41.5	27.9	26.5
.6	06.32	25.3	56.9	41.1	38.0	47.5	09.5	44.1	31.1	30.4
.8	06.36	25.4	57.2	41.8	39.0	48.9	11.5	46.6	34.3	34.4
32.0	0 06.40	0 25.6	0 57.6	1 42.4	2 40.0	3 50.3	5 13.4	6 49.2	8 37.5	10 38.4
.2	06.44	25.8	58.0	43.0	41.0	51.8	15.4	51.7	40.8	42.4
.4	06.48	25.9	58.3	43.7	42.0	53.2	17.3	54.3	44.0	46.3
.6	06.52	26.1	58.7	44.3	43.0	54.7	19.3	56.8	47.2	50.3
.8	06.56	26.2	59.0	45.0	44.0	56.1	21.2	59.4	50.4	54.3
33.0	0 06.60	0 26.4	0 59.4	1 45.6	2 45.0	3 57.5	5 23.2	7 01.9	8 53.7	10 58.2
.2	06.64	26.6	59.8	46.2	46.0	59.0	25.1	04.5	56.9	11 02.2
.4	06.68	26.7	1 00.1	46.9	47.0	4 00.4	27.1	07.0	9 00.1	06.2
.6	06.72	26.9	00.5	47.5	48.0	01.8	29.1	09.6	03.3	10.1
.8	06.76	27.0	00.8	48.2	49.0	03.3	31.0	12.1	06.5	14.1
34.0	0 06.80	0 27.2	1 01.2	1 48.8	2 50.0	4 04.7	5 33.0	7 14.7	9 09.8	11 18.1
.2	06.84	27.4	01.6	49.4	51.0	06.2	34.9	17.2	13.0	22.0
.4	06.88	27.5	01.9	50.1	52.0	07.6	36.9	19.8	16.2	26.0
.6	06.92	27.7	02.3	50.7	53.0	09.0	38.8	22.4	19.4	30.0
.8	06.96	27.8	02.6	51.4	54.0	10.5	40.8	24.9	22.7	33.9
35.0	0 07.00	0 28.0	1 03.0	1 52.0	2 55.0	4 11.9	5 42.8	7 27.5	9 25.9	11 37.9
.2	07.04	28.2	03.4	52.6	56.0	13.3	44.7	30.0	29.1	41.8
.4	07.08	28.3	03.7	53.3	57.0	14.8	46.7	32.6	32.3	45.8
.6	07.12	28.5	04.1	53.9	58.0	16.2	48.6	35.1	35.5	49.8
.8	07.16	28.6	04.4	54.6	59.0	17.7	50.6	37.7	38.8	53.7
36.0	0 07.20	0 28.8	1 04.8	1 55.2	3 00.0	4 19.1	5 52.5	7 40.2	9 42.0	11 57.7
.2	07.24	29.0	05.2	55.8	01.0	20.5	54.5	42.8	45.2	12 01.7
.4	07.28	29.1	05.5	56.5	02.0	22.0	56.5	45.3	48.4	05.6
.6	07.32	29.3	05.9	57.1	03.0	23.4	58.4	47.8	51.6	09.6
.8	07.36	29.4	06.2	57.8	04.0	24.8	6 00.4	50.4	54.9	13.5
37.0	0 07.40	0 29.6	1 06.6	1 58.4	3 05.0	4 26.3	6 02.3	7 52.9	9 58.1	12 17.5
.2	07.44	29.8	07.0	59.0	06.0	27.7	04.3	55.5	10 01.3	21.5
.4	07.48	29.9	07.3	59.7	07.0	29.2	06.2	58.0	04.5	25.4
.6	07.52	30.1	07.7	2 00.3	08.0	30.6	08.2	8 00.6	07.7	29.4
.8	07.56	30.2	08.0	01.0	09.0	32.0	10.1	03.1	11.0	33.3
38.0	0 07.60	0 30.4	1 08.4	2 01.6	3 10.0	4 33.5	6 12.1	8 05.7	10 14.2	12 37.3
.2	07.64	30.6	08.8	02.2	11.0	34.9	14.0	08.2	17.4	41.2
.4	07.68	30.7	09.1	02.9	12.0	36.3	16.0	10.8	20.6	45.2
.6	07.72	30.9	09.5	03.5	13.0	37.8	18.0	13.3	23.8	49.2
.8	07.76	31.0	09.8	04.2	14.0	39.2	19.9	15.9	27.0	53.1
39.0	0 07.80	0 31.2	1 10.2	2 04.8	3 15.0	4 40.7	6 21.9	8 18.4	10 30.2	12 57.1
	1	2	3	4	5	6	7	8	9	10

TABLE VII. — DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

Sc	1	2	3	4	5	6	7	8	9	10
39.0°	0°07.80′	0°31.2′	1°10.2′	2°04.8′	3°15.0′	4°40.7′	6°21.9′	8°18.4′	10°30.2′	12°57.1′
.2	07.84	31.4	10.6	05.4	16.0	42.1	23.8	21.0	33.5	13 01.0
.4	07.88	31.5	10.9	06.1	17.0	43.5	25.8	23.5	36.7	05.0
.6	07.92	31.7	11.3	06.7	18.0	45.0	27.7	26.1	39.9	08.9
.8	07.96	31.8	11.6	07.4	19.0	46.4	29.7	28.6	43.1	12.9
40.0	0 08.00	0 32.0	1 12.0	2 08.0	3 20.0	4 47.9	6 31.6	8 31.2	10 46.3	13 16.8
.2	08.04	32.2	12.4	08.6	20.9	49.3	33.6	33.7	49.5	20.8
.4	08.08	32.3	12.7	09.3	21.9	50.7	35.5	36.3	52.8	24.7
.6	08.12	32.5	13.1	09.9	22.9	52.2	37.5	38.8	56.0	28.7
.8	08.16	32.6	13.4	10.6	23.9	53.6	39.5	41.4	59.2	32.6
41.0	0 08.20	0 32.8	1 13.8	2 11.2	3 24.9	4 55.0	6 41.4	8 43.9	11 02.4	13 36.6
.2	08.24	33.0	14.2	11.8	25.9	56.5	43.4	46.5	05.6	40.5
.4	08.28	33.1	14.5	12.5	26.9	57.9	45.3	49.0	08.8	44.5
.6	08.32	33.3	14.9	13.1	27.9	59.4	47.3	51.6	12.0	48.4
.8	08.36	33.4	15.2	13.8	28.9	5 00.8	49.2	54.1	15.2	52.4
42.0	0 08.40	0 33.6	1 15.6	2 14.4	3 29.9	5 02.2	6 51.2	8 56.6	11 18.4	13 56.3
.2	08.44	33.8	16.0	15.0	30.9	03.7	53.1	59.2	21.7	14 00.3
.4	08.48	33.9	16.3	15.7	31.9	05.1	55.1	9 01.7	24.9	04.2
.6	08.52	34.1	16.7	16.3	32.9	06.5	57.0	04.3	28.1	08.2
.8	08.56	34.2	17.0	17.0	33.9	08.0	59.0	06.8	31.3	12.1
43.0	0 08.60	0 34.4	1 17.4	2 17.6	3 34.9	5 09.4	7 01.0	9 09.4	11 34.5	14 16.1
.2	08.64	34.6	17.8	18.2	35.9	10.9	02.9	11.9	37.7	20.0
.4	08.68	34.7	18.1	18.9	36.9	12.3	04.9	14.5	40.9	24.0
.6	08.72	34.9	18.5	19.5	37.9	13.7	06.8	17.0	44.1	27.9
.8	08.76	35.0	18.8	20.2	38.9	15.2	08.8	19.5	47.4	31.8
44.0	0 08.80	0 35.2	1 19.2	2 20.8	3 39.9	5 16.6	7 10.7	9 22.1	11 50.6	14 35.8
.2	08.84	35.4	19.6	21.4	40.9	18.0	12.7	24.6	53.8	39.7
.4	08.88	35.5	19.9	22.1	41.9	19.5	14.6	27.2	57.0	43.7
.6	08.92	35.7	20.3	22.7	42.9	20.9	16.6	29.7	12 00.2	47.6
.8	08.96	35.8	20.6	23.4	43.9	22.4	18.5	32.3	03.4	51.6
45.0	0 09.00	0 36.0	1 21.0	2 24.0	3 44.9	5 23.8	7 20.5	9 34.8	12 06.6	14 55.5
	1	2	3	4	5	6	7	8	9	10

TABLE VII A. — COEFFICIENTS OF i_1 FOR DEFLECTION ANGLES TO CHORD POINTS OF SPIRAL

Deflection Angle to Chord Point Number	Transit at Chord Point Number										
	T. S. 0	1	2	3	4	5	6	7	8	9	S. C. 10
T. S. 0	0	2	8	18	32	50	72	98	128	162	200
1	1	0	5	14	27	44	65	90	119	152	189
2	4	4	0	8	20	36	56	80	108	140	176
3	9	10	7	0	11	26	45	68	95	126	161
4	16	18	16	10	0	14	32	54	80	110	144
5	25	28	27	22	13	0	17	38	63	92	125
6	36	40	40	36	28	16	0	20	44	72	104
7	49	54	55	52	45	34	19	0	23	50	81
8	64	70	72	70	64	54	40	22	0	26	56
9	81	88	91	90	85	76	63	46	25	0	29
10 S. C.	100	108	112	112	108	100	88	72	52	28	0
	0 T. S.	1	2	3	4	5	6	7	8	9	10 S. C

TABLE VII. B.—SPIRALS—COEFFICIENTS FOR x_c, y_c, p, q

S_c	$\frac{x_c}{l_c}$	$\frac{y_c}{l_c}$	$p = al_c - bD_c$		$q = el_c - fD_c$		S_c
			a	b	e	f	
0°	.000 000	1.000 000	.000 000	.000 00	.500 000	.000 00	0°
30′	.002 909	.999 993	.000 727	.000 00	.499 999	.000 64	30′
1°	.005 818	.999 970	.001 454	.000 01	.499 995	.001 27	1°
30′	.008 726	.999 932	.002 182	.000 03	.499 989	.001 91	30′
2°	.011 635	.999 879	.002 909	.000 04	.499 980	.002 55	2°
30′	.014 542	.999 811	.003 636	.000 07	.499 969	.003 18	30′
3°	.017 450	.999 727	.004 363	.000 10	.499 956	.003 82	3°
30′	.020 357	.999 629	.005 090	.000 14	.499 940	.004 46	30′
4°	.023 263	.999 515	.005 817	.000 18	.499 922	.005 09	4°
30′	.026 169	.999 387	.006 544	.000 23	.499 901	.005 73	30′
5°	.029 073	.999 243	.007 270	.000 28	.499 877	.006 36	5°
30′	.031 977	.999 084	.007 997	.000 34	.499 852	.007 00	30′
6°	.034 880	.998 910	.008 724	.000 40	.499 824	.007 63	6°
30′	.037 781	.998 721	.009 450	.000 47	.499 793	.008 26	30′
7°	.040 681	.998 517	.010 176	.000 54	.499 760	.008 90	7°
30′	.043 581	.998 298	.010 902	.000 62	.499 724	.009 53	30′
8°	.046 478	.998 063	.011 628	.000 71	.499 686	.010 16	8°
30′	.049 374	.997 814	.012 354	.000 80	.499 646	.010 79	30′
9°	.052 269	.997 549	.013 080	.000 90	.499 603	.011 42	9°
30′	.055 162	.997 270	.013 805	.001 00	.499 558	.012 05	30′
10°	.058 053	.996 975	.014 530	.001 11	.499 510	.012 68	10°
30′	.060 942	.996 666	.015 255	.001 22	.499 460	.013 30	30′
11°	.063 829	.996 341	.015 980	.001 34	.499 407	.013 93	11°
30′	.066 714	.996 002	.016 704	.001 47	.499 352	.014 55	30′
12°	.069 598	.995 647	.017 429	.001 60	.499 294	.015 18	12°
30′	.072 478	.995 278	.018 153	.001 73	.499 234	.015 80	30′
13°	.075 357	.994 893	.018 877	.001 87	.499 172	.016 42	13°
30′	.078 233	.994 494	.019 600	.002 02	.499 107	.017 04	30′
14°	.081 106	.994 079	.020 323	.002 17	.499 040	.017 66	14°
30′	.083 977	.993 650	.021 046	.002 33	.498 970	.018 28	30′
15°	.086 846	.993 206	.021 769	.002 49	.498 898	.018 89	15°
30′	.089 711	.992 747	.022 491	.002 65	.498 824	.019 51	30′
16°	.092 574	.992 273	.023 213	.002 83	.498 747	.020 12	16°
30′	.095 433	.991 785	.023 935	.003 01	.498 667	.020 73	30′
17°	.098 290	.991 281	.024 656	.003 19	.498 585	.021 34	17°
30′	.101 143	.990 763	.025 377	.003 38	.498 501	.021 95	30′
18°	.103 993	.990 230	.026 097	.003 57	.498 414	.022 56	18°
30′	.106 840	.989 682	.026 817	.003 77	.498 325	.023 16	30′
19°	.109 683	.989 120	.027 537	.003 98	.498 233	.023 77	19°
30′	.112 523	.988 543	.028 257	.004 19	.498 139	.024 37	30′
20°	.115 360	.987 951	.028 976	.004 40	.498 043	.024 97	20°
30′	.118 192	.987 344	.029 694	.004 62	.497 944	.025 57	30′
21°	.121 021	.986 723	.030 412	.004 85	.497 843	.026 16	21°
30′	.123 846	.986 088	.031 130	.005 08	.497 739	.026 75	30′
22°	.126 667	.985 437	.031 847	.005 32	.497 633	.027 35	22°
30′	.129 483	.984 772	.032 564	.005 56	.497 525	.027 94	30′
23°	.132 296	.984 093	.033 280	.005 80	.497 414	.028 52	23°
30′	.135 105	.983 399	.033 996	.006 05	.497 300	.029 11	30′
24°	.137 909	.982 691	.034 711	.006 31	.497 185	.029 69	24°
30′	.140 708	.981 968	.035 426	.006 57	.497 067	.030 27	30′

TABLE VII.B.—SPIRALS—COEFFICIENTS FOR x_c, y_c, p, q

S_c	$\frac{x_c}{l_c}$	$\frac{y_c}{l_c}$	$p = al_c - bD_c$		$q = el_c - fD_c$		S_c
			a	b	e	f	
25°	.143 504	.981 231	.036 140	.006 84	.496 946	.030 85	25°
30′	.146 294	.980 479	.036 854	.007 11	.496 823	.031 43	30′
26°	.149 080	.979 714	.037 567	.007 39	.496 698	.032 00	26°
30′	.151 861	.978 933	.038 280	.007 67	.496 570	.032 57	30′
27°	.154 638	.978 139	.038 992	.007 96	.496 440	.033 14	27°
30′	.157 409	.977 330	.039 704	.008 25	.496 308	.033 71	30′
28°	.160 176	.976 508	.040 415	.008 54	.496 173	.034 27	28°
30′	.162 937	.975 670	.041 125	.008 85	.496 036	.034 83	30′
29°	.165 693	.974 819	.041 835	.009 15	.495 896	.035 39	29°
30′	.168 444	.973 954	.042 544	.009 46	.495 754	.035 95	30′
30°	.171 189	.973 074	.043 253	.009 78	.495 610	.036 50	30°
30′	.173 929	.972 181	.043 961	.010 10	.495 463	.037 05	30′
31°	.176 664	.971 273	.044 668	.010 43	.495 314	.037 60	31°
30′	.179 392	.970 352	.045 375	.010 76	.495 162	.038 14	30′
32°	.182 116	.969 417	.046 081	.011 09	.495 008	.038 68	32°
30′	.184 833	.968 468	.046 787	.011 43	.494 852	.039 22	30′
33°	.187 544	.967 504	.047 491	.011 78	.494 694	.039 76	33°
30′	.190 250	.966 528	.048 195	.012 13	.494 533	.040 29	30′
34°	.192 949	.965 537	.048 899	.012 48	.494 369	.040 82	34°
30′	.195 643	.964 532	.049 602	.012 84	.494 204	.041 35	30′
35°	.198 330	.963 515	.050 304	.013 20	.494 036	.041 87	35°
30′	.201 010	.962 483	.051 005	.013 57	.493 866	.042 39	30′
36°	.203 685	.961 438	.051 705	.013 94	.493 693	.042 91	36°
30′	.206 353	.960 379	.052 405	.014 32	.493 518	.043 42	30′
37°	.209 014	.959 306	.053 104	.014 70	.493 341	.043 93	37°
30′	.211 669	.958 221	.053 803	.015 09	.493 161	.044 44	30′
38°	.214 317	.957 121	.054 500	.015 48	.492 979	.044 94	38°
30′	.216 959	.956 009	.055 197	.015 87	.492 795	.045 44	30′
39°	.219 593	.954 883	.055 893	.016 27	.492 608	.045 94	39°
30′	.222 221	.953 744	.056 589	.016 67	.492 420	.046 43	30′
40°	.224 841	.952 591	.057 283	.017 08	.492 229	.046 92	40°
30′	.227 455	.951 426	.057 977	.017 49	.492 035	.047 41	30′
41°	.230 061	.950 247	.058 670	.017 91	.491 839	.047 89	41°
30′	.232 660	.949 055	.059 362	.018 33	.491 641	.048 37	30′
42°	.235 252	.947 850	.060 053	.018 75	.491 441	.048 85	42°
30′	.237 836	.946 632	.060 743	.019 18	.491 239	.049 32	30′
43°	.240 413	.945 402	.061 433	.019 61	.491 034	.049 79	43°
30′	.242 982	.944 158	.062 122	.020 05	.490 827	.050 25	30′
44°	.245 544	.942 901	.062 809	.020 49	.490 617	.050 71	44°
30′	.248 098	.941 632	.063 496	.020 93	.490 406	.051 17	30′
45°	.250 644	.940 350	.064 182	.021 38	.490 192	.051 62	45°

TABLE VII-C — MINIMUM LENGTH OF EASEMENT CURVE

MINIMUM LENGTH OF SPIRAL IN FEET

HIGHEST PERMISSIBLE SPEED IN MILES PER HOUR

50 100 200

Limiting Curves

For all curves which are liable to limit the speed of trains, the length of spiral should equal that indicated on the line marked "Superelevation = 8 inches." Longer spirals may be used, provided the increased length does not adversely affect the degree of curve or seriously affect the cost of construction.

Minor Curves

For minor curves the length of spiral should never be less than that indicated on the diagram; an increase of about 50 per cent over the indicated length may be desirable when cost is not seriously affected.

Spirals need not be used when superelevation required for highest permissible speed is less than two inches.

TABLE VIII.—LONG CHORDS AND ACTUAL ARCS.

Degree of Curve.	Actual Arc, One [illegible]	LONG CHORDS.							Degree of Curve.
		2 Sta.	3 Sta.	4 Sta.	5 Sta.	6 Sta.	7 Sta.	8 Sta.	
0° 10'	100,000	200.0	300.0	400.0	500.0	600.0	700.0	800.0	0° 10'
20	000	00.0	00.0	00.0	00.0	00.0	00.0	799.9	20
30	000	00.0	00.0	00.0	00.0	599.9	699.9	99.8	30
40	001	00.0	00.0	00.0	499.9	99.9	99.8	99.7	40
50	001	00.0	00.0	399.9	99.9	99.8	99.7	99.6	50
1° 0	100,001	200.0	300.0	399.9	499.8	599.7	699.6	799.4	1° 0
10	002	00.0	00.0	99.9	99.8	99.6	99.4	99.1	10
20	002	00.0	299.9	99.9	99.7	99.5	99.2	98.9	20
30	003	00.0	99.9	99.8	99.7	99.4	99.0	98.6	30
40	004	00.0	99.9	99.8	99.6	99.3	98.8	98.2	40
50	004	00.0	99.9	99.7	99.5	99.1	98.6	97.9	50
2° 0	100, 5	200.0	299.9	399.7	499.4	598.9	698.3	797.4	2° 0
10	006	00.0	99.9	99.6	[illegible].3	98.7	98.0	97.0	10
20	007	00.0	99.8	99.6	99.2	98.5	97.7	96.5	20
30	008	00.0	99.8	99.5	99.0	98.3	97.3	96.0	30
40	009	199.9	99.8	99.5	98.9	98.1	97.0	95.5	40
50	010	99.9	99.8	99.4	98.8	97.9	96.6	94.9	50
3° 0	100,011	199.9	299.7	399.3	498.6	597.6	696.2	794.3	3° 0
10	013	99.9	99.7	99.2	98.5	97.3	95.7	93.6	10
20	014	99.9	99.7	99.2	98.3	97.0	95.3	92.9	20
30	016	99.9	99.6	99.1	98.1	96.7	94.8	92.2	30
40	017	99.9	99.6	99.0	98.0	96.4	94.3	91.4	40
50	019	99.9	99.6	98.9	97.8	96.1	93.7	90.6	50
4° 0	100,020	199.9	299.5	398.8	497.6	595.7	693.2	789.8	4° 0
10	022	99.9	99.5	98.7	97.4	95.4	92.6	88.9	10
20	024	99.9	99.4	98.6	97.1	95.0	92.0	88.0	20
30	026	99.8	99.4	98.5	96.9	94.6	91.4	87.1	30
40	028	99.8	99.3	98.3	96.7	94.2	90.7	86.1	40
50	030	99.8	99.3	98.2	[illegible]	93.8	90.1	85.1	50
5° 0	100,032	199.8	299.2	398.1	[illegible]	593.4	689.4	784.1	5° 0
10	034	99.8	99.2	98.0	[illegible]	92.9	88.7	83.0	10
20	036	99.8	99.1	97.8	[illegible]	92.4	87.9	81.9	20
30	038	99.8	99.1	97.7	[illegible]	92.0	87.2	80.8	30
40	041	99.8	[illegible].0	97.6	[illegible]	91.5	86.4	79.6	40
50	043	99.7	99.0	97.4	[illegible]	91.0	85.6	78.4	50
6° 0	100,046	199.7	298.9	397.3	[illegible]	590.4	684.7	777.2	6° 0
10	048	99.7	98.8	97.1	[illegible]	89.9	83.9	75.9	10
20	051	99.7	98.8	97.0	[illegible]	89.4	83.0	74.6	20
30	054	99.7	98.7	96.8	[illegible]	88.8	82.1	73.2	30
40	056	99.7	98.6	96.6	[illegible]	88.2	81.2	71.9	40
50	059	99.6	98.6	96.5	[illegible]	87.6	80.3	70.5	50
7° 0	100,062	199.[illegible]	298.5	396.3	[illegible]	587.0	679.3	769.0	7° 0
10	065	99.6	98.4	96.1	[illegible]	86.4	78.3	67.5	10
20	068	99.6	98.4	95.9	[illegible]	85.8	77.3	66.0	20
30	071	99.6	98.3	95.7	[illegible]	85.1	76.3	64.5	30
40	075	99.6	98.2	95.5	[illegible]	84.5	75.2	62.9	40
50	078	99.5	98.1	95.3	[illegible]	83.8	74.1	61.3	50
8° 0	100,081	199.5	298.1	395.1	[illegible]	583.1	673.0	759.7	8° 0
10	085	99.5	98.0	94.9	[illegible]	82.4	71.9	58.0	10
20	088	99.5	97.9	94.7	[illegible]	81.7	70.7	56.3	20
30	092	99.5	97.8	94.5	[illegible]	80.9	69.6	54.6	30
40	095	99.4	97.7	94.3	[illegible]	80.2	68.4	52.8	40
50	099	99.4	97.6	94.1	[illegible]	79.4	67.2	51.0	50
9° 0	100,103	199.4	297.5	393.9	[illegible]	578.6	666.0	749.2	9° 0
10	107	99.4	97.4	93.6	[illegible]	77.8	64.7	47.3	10
20	111	99.3	97.4	93.4	[illegible]	77.0	63.4	45.4	20
30	115	99.3	97.3	93.2	[illegible]	76.2	62.1	43.5	30
40	119	99.3	97.2	92.9	[illegible]	75.4	60.8	41.5	40
50	123	99.3	97.1	92.7	[illegible]	74.5	59.5	39.5	50
10° 0	100,127	199.2	297.0	392.4	[illegible]	573.7	658.1	737.5	10° 0
Degree	Actual Arc.	2 Sta.	3 Sta.	4 Sta.	5 Sta.	6 Sta.	7 Sta.	8 Sta.	Degree

TABLE VIII.—LONG CHORDS AND ACTUAL ARCS.

Degree of Curve.	Actual Arc, One Station.	LONG CHORDS. 2 Sta.	3 Sta.	4 Sta.	5 Sta.	6 Sta.	7 Sta.	8 Sta.	Degree of Curve.
10° 0′	100.127	199.2	297.0	392.4	484.9	573.7	658.1	737.5	10° 0′
10	131	99.2	96.9	92.2	84.4	72.8	56.7	35.5	10
20	136	99.2	96.8	91.9	83.9	71.9	55.3	33.4	20
30	140	99.2	96.7	91.7	83.4	71.0	53.9	31.3	30
40	145	99.1	96.5	91.4	82.8	70.1	52.4	29.1	40
50	149	99.1	96.4	91.1	82.3	69.2	51.0	27.0	50
11° 0	100.154	199.1	296.3	390.8	481.8	568.2	649.5	724.8	11° 0
10	158	99.1	96.2	90.6	81.2	67.3	48.0	22.5	10
20	163	99.0	96.1	90.3	80.7	66.3	46.5	20.3	20
30	168	99.0	96.0	90.0	80.1	65.3	44.9	18.0	30
40	173	99.0	95.9	89.7	79.5	64.3	43.3	15.7	40
50	178	98.9	95.7	89.4	78.9	63.3	41.8	13.3	50
12° 0	100.183	198.9	295.6	389.1	478.3	562.3	640.1	710.9	12° 0
10	188	98.9	95.5	88.8	77.7	61.3	38.5	08.5	10
20	193	98.8	95.4	88.5	77.1	60.2	36.9	06.1	20
30	199	98.8	95.3	88.2	76.5	59.2	35.2	03.7	30
40	204	98.8	95.1	87.9	75.9	58.1	33.5	01.2	40
50	209	98.7	95.0	87.6	75.3	57.0	31.8	698.6	50
13° 0	100.215	198.7	294.9	387.2	474.6	555.9	630.1	696.1	13° 0
10	220	98.7	94.7	86.9	74.0	54.8	28.3	93.5	10
20	226	98.6	94.6	86.6	73.3	53.7	26.5	90.9	20
30	232	98.6	94.5	86.3	72.7	52.5	24.8	88.3	30
40	237	98.6	94.3	85.9	72.0	51.4	22.9	85.7	40
50	243	98.5	94.2	85.6	71.3	50.2	21.1	83.0	50
14° 0	100.249	198.5	294.1	385.2	470.6	549.1	619.3	680.3	14° 0
10	255	98.5	93.9	84.9	70.0	47.9	17.4	77.5	10
20	261	98.4	93.8	84.5	69.3	46.7	15.5	74.8	20
30	267	98.4	93.6	84.2	68.6	45.5	13.6	72.0	30
40	274	98.4	93.5	83.8	67.8	44.2	11.7	69.2	40
50	280	98.3	93.3	83.4	67.1	43.0	09.8	66.3	50
15° 0	100.286	198.3	293.2	383.1	466.4	541.7	607.8	663.5	15° 0
10	293	98.3	93.0	82.7	65.7	40.5	05.8	60.6	10
20	299	98.2	92.9	82.3	64.9	39.2	03.8	57.7	20
30	306	98.2	92.7	81.9	64.2	37.9	01.8	54.8	30
40	312	98.1	92.6	81.5	63.4	36.6	599.8	51.8	40
50	319	98.1	92.4	81.2	62.6	35.3	97.8	48.8	50
16° 0	100.326	198.1	292.3	380.8	461.9	534.0	595.7	645.8	16° 0
10	332	98.0	92.1	80.4	61.1	32.6	93.6	42.8	10
20	339	98.0	91.9	80.0	60.3	31.3	91.5	39.7	20
30	346	97.9	91.8	79.6	59.5	29.9	89.4	36.6	30
40	353	97.9	91.6	79.1	58.7	28.6	87.3	33.6	40
50	361	97.8	91.4	78.7	57.9	27.2	85.1	30.4	50
17° 0	100.368	197.8	291.3	378.3	457.1	525.8	582.9	627.3	17° 0
10	375	97.8	91.1	77.9	56.2	24.4	80.7	24.1	10
20	382	97.7	90.9	77.5	55.4	22.9	78.5	20.9	20
30	390	97.7	90.7	77.0	54.6	21.5	76.3	17.7	30
40	397	97.6	90.6	76.6	53.7	20.1	74.1	14.5	40
50	405	97.6	90.4	76.2	52.9	18.6	71.8	11.2	50
18° 0	100.412	197.5	290.2	375.7	452.0	517.2	569.6	608.0	18° 0
10	420	97.5	90.0	75.3	51.1	15.7	67.3	04.7	10
20	428	97.4	89.8	74.8	50.4	14.2	65.0	01.3	20
30	436	97.4	89.7	74.4	49.4	12.7	62.7	598.0	30
40	444	97.4	89.5	73.9	48.5	11.2	60.3	94.7	40
50	452	97.3	89.3	73.5	47.6	09.7	58.0	91.3	50
19° 0	100.460	197.3	289.1	373.0	446.7	508.1	555.6	587.9	19° 0
10	468	97.2	88.9	72.6	45.8	06.6	53.3	84.5	10
20	476	97.2	88.7	72.1	44.9	05.0	50.9	81.0	20
30	484	97.1	88.5	71.6	44.0	03.5	48.5	77.6	30
40	493	97.1	88.3	71.1	43.0	01.9	46.0	74.1	40
50	501	97.0	88.1	70.7	42.1	00.3	43.6	70.6	50
20° 0	100.510	197.0	287.9	370.2	441.1	498.7	541.1	567.1	20° 0
Degree	Actual Arc.	2 Sta.	3 Sta.	4 Sta.	5 Sta.	6 Sta.	7 Sta.	8 Sta.	Degree

TABLE IX.—ACRES FOR STRIP 100 FEET WIDE.

0.00	2.18	0.60	263.54	1.20	524.90	1.80	786.26	2.40	1047.62
.01	6.53	.61	267.89	.21	529.25	.81	790.61	.41	1051.97
.02	10.89	.62	272.25	.22	533.61	.82	794.97	.42	1056.33
.03	15.25	.63	276.61	.23	537.97	.83	799.33	.43	1060.69
.04	19.60	.64	280.96	.24	542.32	.84	803.68	.44	1065.04
0.05	23.96	0.65	285.32	1.25	546.68	1.85	808.04	2.45	1069.40
.06	28.31	.66	289.67	.26	551.03	.86	812.39	.46	1073.75
.07	32.67	.67	294.03	.27	555.39	.87	816.75	.47	1078.11
.08	37.03	.68	298.39	.28	559.75	.88	821.11	.48	1082.47
.09	41.38	.69	302.74	.29	564.10	.89	825.46	.49	1086.82
0.10	74	0.70	307.10	1.30	568.46	1.90	829.82	2.50	1091.18
.11	09	.71	311.45	.31	572.81	.91	834.17	.51	1095.53
.12	45	.72	315.81	.32	577.17	.92	838.53	.52	1099.89
.13	81	.73	320.17	.33	581.53	.93	842.89	.53	1104.25
.14	16	.74	324.52	.34	585.88	.94	847.24	.54	1108.60
0.15	52	0.75	328.88	1.35	590.24	1.95	851.60	2.55	1112.96
.16	87	.76	333.23	.36	594.59	.96	855.96	.56	1117.31
.17	23	.77	337.59	.37	598.95	.97	860.31	.57	1121.67
.18	...59	.78	341.95	.38	603.31	.98	864.67	.58	1126.03
.19	84.94	.79	346.30	.39	607.66	.99	869.02	.59	1130.38
0.20	89.30	0.80	350.66	1.40	612.02	2.00	873.38	2.60	1134.74
.21	93.65	.81	355.01	.41	616.37	.01	877.73	.61	1139.09
.22	98.01	.82	359.37	.42	620.73	.02	882.09	.62	1143.45
.23	102.37	.83	363.73	.43	625.09	.03	886.45	.63	1147.81
.24	106.72	.84	368.08	.44	629.44	.04	890.80	.64	1152.16
0.25	111.08	0.85	372.44	1.45	633.80	2.05	895.16	2.65	1156.52
.26	115.43	.86	376.79	.46	638.15	.06	899.51	.66	1160.87
.27	119.79	.87	381.15	.47	642.51	.07	903.87	.67	1165.23
.28	124.15	.88	385.51	.48	646.87	.08	908.23	.68	1169.59
.29	128.50	.89	389.86	.49	651.22	.09	912.58	.69	1173.94
0.30	132.86	0.90	394.22	1.50	655.58	2.10	916.94	2.70	1178.30
.31	137.21	.91	398.57	.51	659.93	.11	921.29	.71	1182.65
.32	141.57	.92	402.93	.52	664.29	.12	925.65	.72	1187.01
.33	1[illegible]5.93	.93	407.29	.53	668.65	.13	930.01	.73	1191.37
.34	150.28	.94	411.64	.54	673.00	.14	934.36	.74	1195.72
0.35	154.64	0.95	416.00	1.55	677.36	2.15	938.72	2.75	1200.08
.36	158.99	.96	420.35	.56	681.71	.16	943.07	.76	1204.43
.37	163.35	.97	424.71	.57	686.07	.17	947.43	.77	1208.79
.38	167.71	.98	429.07	.58	690.43	.18	951.79	.78	1213.15
.39	172.06	.99	433.42	.59	694.78	.19	956.14	.79	1217.50
0.40	176.42	1.00	437.78	1.60	699.14	2.20	960.50	2.80	1221.86
.41	180.77	.01	442.13	.61	703.49	.21	964.85	.81	1226.21
.42	185.13	.02	446.49	.62	707.85	.22	969.21	.82	1230.57
.43	189.49	.03	450.85	.63	712.21	.23	973.57	.83	1234.93
.44	193.84	.04	455.10	.64	716.56	.24	977.92	.84	1239.28
0.45	198.20	1.05	459.56	1.65	720.92	2.25	982.28	2.85	1243.64
.46	202.55	.06	463.91	.66	725.27	.26	986.63	.86	1247.99
.47	206.91	.07	468.27	.67	729.63	.27	990.99	.87	1252.35
.48	211.27	.08	472.63	.68	733.99	.28	995.35	.88	1256.71
.49	215.62	.09	476.98	.69	738.34	.29	999.70	.89	1261.06
0.50	219.98	1.10	481.34	1.70	742.70	2.30	1004.06	2.90	1265.42
.51	224.33	.11	485.69	.71	747.05	.31	1008.41	.91	1269.77
.52	228.69	.12	490.05	.72	751.41	.32	1012.77	.92	1274.13
.53	233.05	.13	494.41	.73	755.77	.33	1017.13	.93	1278.49
.54	237.40	.14	498.76	.74	760.12	.34	1021.48	.94	1282.84
0.55	241.76	1.15	503.12	1.75	764.48	2.35	1025.84	2.95	1287.20
.56	246.11	.16	507.47	.76	768.83	.36	1030.19	.96	1291.55
.57	250.47	.17	511.83	.77	773.19	.37	1034.55	.97	1295.91
.58	254.83	.18	516.19	.78	777.55	.38	1038.91	.98	1300.27
.59	259.18	.19	520.54	.79	781.90	.39	1043.26	.99	1304.62
0.60	263.54	1.20	524.90	1.80	786.26	2.40	1047.62	3.00	1308.98

TABLE X.—CURVES FOR METRIC SYSTEM

Defl. Angle 20 m. Chord	Radius Meters	Log. Radius.	Tang. [redacted]	Mid. Ord.	Length Arc 20 m. Chord	Equiv. U. S. Curve	[redacted] Angle 20 m. Chord
0° 10′	3437.75	3.536274	.058	.015	20.000	0°30′	0° 10′
20	1718.88	3.235246	.116	.019	20.000	1 01	20
30	1145.93	3.059158	.175	.044	20.000	1 31	30
40	859.46	2.934224	.233	.058	20.000	2 02	40
50	687.57	2.837319	.291	.073	20.001	2 32	50
1°	572.99	2.758145	.349	.087	20.001	3 03	1°

TABLE XI.—BAROMETRIC HEIGHTS.

Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.
31.00	0	30.40	533	29.80	1076	29.20	1630	28.60	2196
30.99	9	39	542	79	1085	19	1639	59	2205
98	18	38	551	78	1094	18	1649	58	2215
97	27	37	559	77	1103	17	1658	57	2224
96	35	36	569	76	1113	16	1668	56	2234
30.95	44	30.35	578	29.75	1122	29.15	1677	28.55	2243
94	53	34	587	74	1132	14	1687	54	2253
93	62	33	596	73	1141	13	1696	53	2263
92	71	32	605	72	1150	12	1706	52	2272
91	80	31	613	71	1159	11	1715	51	2282
30.90	88	30.30	622	29.70	1169	29.10	1725	28.50	2291
89	97	29	631	69	1177	09	1734	49	2301
88	106	28	640	68	1186	08	1743	48	2310
87	115	27	649	67	1195	07	1752	47	2320
86	124	26	658	66	1205	06	1762	46	2329
30.85	133	30.25	667	29.65	1214	29.05	1771	28.45	2339
84	142	24	676	64	1224	04	1781	44	2349
83	151	23	685	63	1233	03	1790	43	2358
82	160	22	694	62	1242	02	1799	42	2368
81	168	21	703	61	1251	01	1809	41	2378
30.80	177	30.20	712	29.60	1260	29.00	1818	28.40	2387
79	186	19	721	59	1269	28.99	1827	39	2397
78	195	18	730	58	1278	98	1837	38	2407
77	203	17	740	57	1287	97	1846	37	2416
76	212	16	749	56	1296	96	1856	36	2426
30.75	221	30.15	758	29.55	1305	28.95	1865	28.35	2435
74	230	14	767	54	1314	94	1875	34	2445
73	239	13	776	53	1324	93	1884	33	2455
72	247	12	785	52	1333	92	1894	32	2464
71	256	11	794	51	1342	91	1903	31	2474
30.70	265	30.10	803	29.50	1352	28.90	1913	28.30	2483
69	274	09	812	49	1361	89	1922	29	2493
68	283	08	821	48	1370	88	1931	28	2503
67	292	07	830	47	1379	87	1941	27	2512
66	301	06	839	46	1389	86	1950	26	2522
30.65	310	30.05	849	29.45	1398	28.85	1960	28.25	2531
64	318	04	857	44	1408	84	1969	24	2541
63	327	03	866	43	1417	83	1979	23	2551
62	336	02	875	42	1426	82	1988	22	2561
61	345	01	884	41	1435	81	1998	21	2570
30.60	354	30.00	893	29.40	1445	28.80	2007	28.20	2580
59	363	29.99	903	39	1454	79	2016	19	2590
58	372	98	911	38	1464	78	2026	18	2600
57	381	97	920	37	1473	77	2035	17	2609
56	390	96	929	36	1482	76	2044	16	2619
30.55	399	29.95	938	29.35	1491	28.75	2054	28.15	2628
54	407	94	947	34	1500	74	2063	14	2638
53	416	93	956	33	1509	73	2073	13	2648
52	425	92	965	32	1519	72	2082	12	2658
51	434	91	976	31	1528	71	2091	11	2667
30.50	443	29.90	985	29.30	1537	28.70	2101	28.10	2677
49	452	89	994	29	1546	69	2111	09	2687
48	461	88	1002	28	1556	68	2120	08	2696
47	470	87	1012	27	1565	67	2129	07	2706
46	479	86	1021	26	1574	66	2139	06	2715
30.45	488	29.85	1030	29.25	1583	28.65	2148	28.05	2726
44	497	84	1039	24	1593	64	2158	04	2735
43	506	83	1049	23	1603	63	2168	03	2745
42	515	82	1058	22	1612	62	2177	02	2755
41	524	81	1067	21	1621	61	2186	01	2765
30.40	533	29.80	1076	29.20	1630	28.60	2196	28.00	2774

TABLE XI.—BAROMETRIC HEIGHTS.

Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.
28.00	2774	27.40	3365	26.80	3968	26.20	4585	25.60	5216
27.99	2784	39	3375	79	3978	19	4596	59	5227
98	2794	38	3384	78	3988	18	4606	58	5237
97	2804	37	3394	77	3999	17	4617	57	5248
96	2813	36	3404	76	4009	16	4627	56	5259
27.95	2823	27.35	3414	26.75	4019	26.15	4638	25.55	5270
94	2833	34	3424	74	4030	14	4648	54	5281
93	2843	33	3434	73	4040	13	4658	53	5291
92	2853	32	3444	72	4050	12	4669	52	5302
91	2863	31	3454	71	4060	11	4679	51	5312
27.90	2873	27.30	3464	26.70	4070	26.10	4690	25.50	5323
89	2882	29	3474	69	4081	09	4700	49	5333
88	2892	28	3484	68	4091	08	4711	48	5344
87	2901	27	3494	67	4101	07	4721	47	5355
86	2911	26	3504	66	4111	06	4731	46	5365
27.85	2921	27.25	3514	26.65	4122	26.05	4742	25.45	5376
84	2930	24	3524	64	4132	04	4752	44	5387
83	2940	23	3534	63	4142	03	4763	43	5397
82	2950	22	3544	62	4152	02	4773	42	5408
81	2960	21	3554	61	4163	01	4784	41	5419
27.80	2969	27.20	3564	26.60	4173	26.00	4794	25.40	5429
79	2979	19	3574	59	4183	25.99	4805	39	5440
78	2989	18	3584	58	4193	98	4815	38	5451
77	2999	17	3594	57	4203	97	4826	37	5462
76	3009	16	3604	56	4213	96	4836	36	5473
27.75	3019	27.15	3614	26.55	4223	25.95	4847	25.35	5483
74	3029	14	3624	54	4233	94	4857	34	5494
73	3039	13	3634	53	4244	93	4868	33	5505
72	3048	12	3644	52	4254	92	4878	32	5516
71	3058	11	3654	51	4264	91	4889	31	5527
27.70	3068	27.10	3665	26.50	4274	25.90	4899	25.30	5537
69	3078	09	3675	49	4284	89	4910	29	5548
68	3087	08	3685	48	4294	88	4920	28	5559
67	3097	07	3695	47	4304	87	4931	27	5570
66	3107	06	3705	46	4315	86	4941	26	5581
27.65	3117	27.05	3715	26.45	4326	25.85	4952	25.25	5592
64	3126	04	3725	44	4336	84	4962	24	5602
63	3136	03	3735	43	4347	83	4973	23	5613
62	3146	02	3745	42	4357	82	4983	22	5624
61	3156	01	3755	41	4368	81	4994	21	5635
27.60	3166	27.00	3765	26.40	4378	25.80	5004	25.20	5646
59	3176	26.99	3775	39	4388	79	5014	19	5657
58	3186	98	3785	38	4399	78	5025	18	5668
57	3196	97	3795	37	4409	77	5036	17	5679
56	3206	96	3806	36	4419	76	5046	16	5689
27.55	3216	26.95	3816	26.35	4430	25.75	5057	25.15	5700
54	3225	94	3826	34	4440	74	5067	14	5711
53	3235	93	3836	33	4450	73	5078	13	5722
52	3245	92	3846	32	4461	72	5088	12	5733
51	3255	91	3856	31	4472	71	5099	11	5744
27.50	3265	26.90	3866	26.30	4482	25.70	5110	25.10	5754
49	3275	89	3876	29	4492	69	5121	09	5765
48	3285	88	3886	28	4502	68	5132	08	5776
47	3295	87	3897	27	4513	67	5142	07	5787
46	3305	86	3907	26	4523	66	5153	06	5798
27.45	3315	26.85	3917	26.25	4533	25.65	5164	25.05	5809
44	3325	84	3927	24	4544	64	5174	04	5820
43	3335	83	3938	23	4554	63	5185	03	5831
42	3345	82	3948	22	4565	62	5195	02	5842
41	3355	81	3958	21	4575	61	5206	01	5853
27.40	3365	26.80	3968	26.20	4585	25.60	5216	25.00	5863

TABLE XI.—BAROMETRIC HEIGHTS.

Barometer Readings. Inches	Hgts. Feet	Barometer Readings. Inches	Hgts. Feet	Barometer Readings. Inches	Hgts. Feet	Barometer Readings. Inches	Hgts. Feet	Barometer Readings. Inches	Hgts. Feet.
25.00	5863	24.40	6525	23.80	7203	23.20	7900	22.60	8615
24.99	5874	39	6536	79	7214	19	7912	59	8627
98	5885	38	6547	78	7226	18	7923	58	8638
97	5896	37	6559	77	7237	17	7935	57	8650
96	5907	36	6570	76	7249	16	7946	56	8661
24.95	5918	24.35	6581	23.75	7261	23.15	7958	22.55	8673
94	5929	34	6592	74	7272	14	7969	54	8685
93	5940	33	6603	73	7283	13	7981	53	8697
92	5950	32	6615	72	7294	12	7992	52	8709
91	5962	31	6626	71	7305	11	8004	51	8721
24.90	5972	24.30	6637	23.70	7316	23.10	8015	22.50	8733
89	5983	29	6648	69	7327	09	8027	49	8745
88	5994	28	6659	68	7339	08	8039	48	8757
87	6005	27	6671	67	7350	07	8051	47	8769
86	6016	26	6682	66	7362	06	8063	46	8781
24.85	6027	24.25	6693	23.65	7374	23.05	8075	22.45	8793
84	6038	24	6705	64	7386	04	8086	44	8806
83	6049	23	6716	63	7398	03	8098	43	8818
82	6060	22	6727	62	7409	02	8110	42	8830
81	6071	21	6738	61	7421	01	8122	41	8842
24.80	6082	24.20	6750	23.60	7433	23.00	8134	22.40	8855
79	6093	19	6761	59	7445	22.99	8146	39	8867
78	6104	18	6772	58	7456	98	8158	38	8879
77	6115	17	6783	57	7468	97	8170	37	8891
76	6126	16	6795	56	7480	96	8182	36	8904
24.75	6137	24.15	6806	23.55	7492	22.95	8194	22.35	8916
74	6148	14	6817	54	7503	94	8206	34	8928
73	6159	13	6828	53	7515	93	8218	33	8941
72	6170	12	6840	52	7527	92	8230	32	8953
71	6181	11	6851	51	7539	91	8242	31	8965
24.70	6192	24.10	6862	23.50	7550	22.90	8254	22.30	8977
69	6203	09	6873	49	7562	89	8266	29	8990
68	6214	08	6885	48	7574	88	8278	28	9002
67	6225	07	6896	47	7585	87	8290	27	9014
66	6236	06	6907	46	7597	86	8302	26	9026
24.65	6247	24.05	6919	23.45	7609	22.85	8314	22.25	9039
64	6258	04	6930	44	7621	84	8326	24	9051
63	6269	03	6941	43	7633	83	8338	23	9063
62	6280	02	6953	42	7644	82	8350	22	9075
61	6291	01	6964	41	7656	81	8362	21	9088
24.60	6302	24.00	6976	23.40	7667	22.80	8374	22.20	9100
59	6313	23.99	6987	39	7679	79	8386	19	9113
58	6324	98	6999	38	7690	78	8398	18	9125
57	6335	97	7010	37	7702	77	8410	17	9138
56	6346	96	7022	36	7713	76	8422	16	9150
24.55	6357	23.95	7033	23.35	7725	22.75	8434	22.15	9162
54	6368	94	7045	34	7736	74	8446	14	9174
53	6379	93	7056	33	7748	73	8458	13	9187
52	6390	92	7068	32	7759	72	8470	12	9199
51	6401	91	7079	31	7771	71	8482	11	9212
24.50	6412	23.90	7090	23.30	7782	22.70	8495	22.10	9224
49	6424	89	7101	29	7793	69	8507	09	9236
48	6435	88	7113	28	7805	68	8519	08	9249
47	6446	87	7124	27	7817	67	8531	07	9262
46	6458	86	7135	26	7829	66	8543	06	9274
24.45	6469	23.85	7146	23.25	7841	22.65	8555	22.05	9286
44	6480	84	7157	24	7853	64	8567	04	9298
43	6491	83	7168	23	7865	63	8579	03	9311
42	6503	82	7180	22	7876	62	8591	02	9323
41	6514	81	7191	21	7888	61	8603	01	9336
24.40	6525	23.80	7203	23.20	7900	22.60	8615	22.00	9348

TABLE XI.—BAROMETRIC HEIGHTS.

Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.	Barometer Readings. Inches	Hgts. Feet.
22.00	9348	21.40	10101	20.80	10876	20.20	11673
21.99	9360	39	10114	79	10889	19	11687
98	9372	38	10126	78	10902	18	11700
97	9384	37	10139	77	10915	17	11714
96	9397	36	10151	76	10928	16	11727
21.95	9410	21.35	10164	20.75	10941	20.15	11741
94	9422	34	10176	74	10954	14	11754
93	9435	33	10189	73	10967	13	11768
92	9447	32	10202	72	10980	12	11781
91	9460	31	10214	71	10993	11	11795
21.90	9472	21.30	10228	20.70	11006	20.10	11808
89	9485	29	10241	69	11019	09	11821
88	9497	28	10253	68	11032	08	11835
87	9510	27	10266	67	11045	07	11859
86	9522	26	10278	66	11058	06	11863
21.85	9535	21.25	10291	20.65	11071	20.05	11877
84	9547	24	10304	64	11084	04	11891
83	9560	23	10317	63	11097	03	11905
82	9572	22	10330	62	11110	02	11918
81	9585	21	10343	61	11123	01	11932
21.80	9597	21.20	10355	20.60	11136	20.00	11945
79	9610	19	10368	59	11149		
78	9622	18	10381	58	11163		
77	9635	17	10394	57	11176		
76	9647	16	10407	56	11190		
21.75	9660	21.15	10420	20.55	11204		
74	9672	14	10432	54	11217		
73	9685	13	10445	53	11230		
72	9697	12	10458	52	11243		
71	9710	11	10471	51	11257		
21.70	9722	21.10	10484	20.50	11270		
69	9735	09	10497	49	11284		
68	9747	08	10509	48	11297		
67	9760	07	10522	47	11311		
66	9772	06	10535	46	11324		
21.65	9785	21.05	10548	20.45	11338		
64	9797	04	10561	44	11351		
63	9810	03	10574	43	11364		
62	9822	02	10587	42	11377		
61	9835	01	10600	41	11391		
21.60	9848	21.00	10613	20.40	11404		
59	9861	20.99	10627	39	11418		
58	9873	98	10640	38	11431		
57	9886	97	10654	37	11444		
56	9898	96	10667	36	11457		
21.55	9911	20.95	10681	20.35	11470		
54	9923	94	10694	34	11483		
53	9936	93	10707	33	11496		
52	9949	92	10720	32	11509		
51	9962	91	10733	31	11523		
21.50	9974	20.90	10746	20.30	11536		
49	9987	89	10759	29	11550		
48	9999	88	10772	28	11563		
47	10012	87	10785	27	11577		
46	10025	86	10798	26	11591		
21.45	10038	20.85	10811	20.25	11605		
44	10050	84	10824	24	11618		
43	10063	83	10837	23	11632		
42	10075	82	10850	22	11645		
41	10088	81	10863	21	11659		
21.40	10101	20.80	10876	20.20	11673		

N.	0	1	2	3	4	5	6	7	8	9	Diff.
100	000000	0434	0868	1301	1734	2166	2598	3029	3461	3891	432
101	4321	4751	5181	5609	6038	6466	6894	7321	7748	8174	428
102	8600	9026	9451	9876	*0300	*0724	*1147	*1570	*1993	*2415	424
103	012837	3259	3680	4100	4521	4940	5360	5779	6197	6616	420
104	7033	7451	7868	8284	8700	9116	9532	9947	*0361	*0775	416
105	021189	1603	2016	2428	2841	3252	3664	4075	4486	4896	412
106	5306	5715	6125	6533	6942	7350	7757	8164	8571	8978	408
107	9384	9789	*0195	*0600	*1004	*1408	*1812	*2216	*2619	*3021	404
108	033424	3826	4227	4628	5029	5430	5830	6230	6629	7028	400
109	7426	7825	8223	8620	9017	9414	9811	*0207	*0602	*0998	397

N.	Diff.	1	2	[illegible]	4	[illegible]	6	7	8	9	Diff.
PROPORTIONAL PARTS	434	43	87	130	174	217	260	304	347	391	434
	433	43	87	130	173	217	260	303	346	390	433
	432	43	86	130	173	216	259	302	346	389	432
	431	43	86	129	172	216	259	302	345	388	431
	430	43	86	129	172	215	258	301	344	387	430
	429	43	86	129	172	215	257	300	343	386	429
	428	43	86	128	171	214	257	300	342	385	428
	427	43	85	128	171	214	256	299	342	384	427
	426	43	85	128	170	213	256	298	341	383	426
	425	43	85	128	170	213	255	298	340	383	425
	424	42	85	127	170	212	254	297	339	382	424
	423	42	85	127	169	212	254	296	338	381	423
	422	42	84	127	169	211	253	295	338	380	[illegible]
	421	42	84	126	168	211	253	295	337	379	421
	420	42	84	126	168	210	252	294	336	378	420
	419	42	84	126	168	210	251	293	335	377	419
	418	42	84	125	167	209	251	293	[illegible]	376	418
	417	42	83	125	167	209	250	292	334	375	417
	416	42	83	125	166	208	250	291	333	374	416
	415	42	83	125	166	208	249	291	332	374	415
	414	41	83	124	166	207	248	290	331	373	414
	413	41	83	124	165	207	248	289	330	372	413
	412	41	82	124	165	206	247	288	330	371	412
	411	41	82	123	164	206	247	288	329	370	411
	410	41	82	123	164	205	246	287	328	369	410
	409	41	82	123	164	205	245	286	327	368	409
	408	41	82	122	163	204	245	286	326	367	408
	407	41	81	122	163	204	244	285	326	366	407
	406	41	81	122	162	203	244	284	325	365	406
	405	41	81	122	162	203	243	284	324	365	405
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	202	242	283	323	364	404
					[illegible]	202	242	282	322	363	403
					[illegible]	201	241	281	322	362	402
					[illegible]	201	241	281	321	361	401
					[illegible]	200	240	280	320	360	400
					[illegible]	200	239	279	319	359	399
					[illegible]	199	239	279	318	358	398
					[illegible]	199	238	278	318	357	397
					[illegible]	198	238	277	317	356	396
					[illegible]	198	237	277	316	356	395
					[illegible]	197	236	276	315	355	394
					[illegible]	197	236	275	314	354	393
					[illegible]	196	235	274	314	353	392
					[illegible]	196	235	274	313	352	391
					[illegible]	195	234	273	312	351	390
					[illegible]	195	233	272	311	350	389
					[illegible]	194	233	272	310	349	388
						5	6	7	8	9	Diff.

N.	0	1	2	3	4	5	6	7	8
110	041393	1787	2182	2576	2969	3362	3755	4148	4540
111	5323	5714	6105	6495	6885	7275	7664	8053	8442
112	9218	9606	9993	*0380	*0766	*1153	*1538	*1924	*2309
113	053078	3463	3846	4230	4613	4996	5378	5760	6142
114	6905	7286	7666	8046	8426	8805	9185	9563	9942
115	060698	1075	1452	1829	2206	2582	2958	3333	3709
116	4458	4832	5206	5580	5953	6326	6699	7071	7443
117	8186	8557	8928	9298	9668	*0038	*0407	*0776	*1145
118	071882	2250	2617	2985	3352	3718	4085	4451	4816
119	5547	5912	6276	6640	7004	7368	7731	8094	8457
120	079181	9543	9904	*0266	*0626	*0987	*1347	*1707	*2067
121	082785	3144	3503	3861	4219	4576	4934	5291	5647
122	6360	6716	7071	7426	7781	8136	8490	8845	9198
123	9905	*0258	*0611	*0963	*1315	*1667	*2018	*2370	*2721
124	093422	3772	4122	4471	4820	5169	5518	5866	6215

N.	Diff.	1	2	3	4	5	6	7	8
PROPORTIONAL PARTS	387	39	77	116	155	194	232	271	310
	386	39	77	116	154	193	232	270	309
	385	39	77	116	154	193	231	270	308
	384	38	77	115	154	192	230	269	307
	383	38	77	115	153	192	230	268	306
	382	38	76	115	153	191	229	267	306
	381	38	76	114	152	191	229	267	305
	380	38	76	114	152	190	228	266	304
	379	38	76	114	152	190	227	265	303
	378	38	76	113	151	189	227	265	302
	377	38	75	113	151	189	226	264	302
	376	38	75	113	150	188	226	263	301
	375	38	75	113	150	188	225	263	300
	374	37	75	112	150	187	224	262	299
	373	37	75	112	149	187	224	261	298
	372	37	74	112	149	186	223	260	298
	371	37	74	111	148	186	223	260	297
	370	37	74	111	148	185	222	259	296
	369	37	74	111	148	185	221	258	295
	368	37	74	110	147	184	221	258	294
	367	37	73	110	147	184	220	257	294
	366	37	73	110	146	183	220	256	293
	365	37	73	110	146	183	219	256	292
	364	36	73	109	146	182	218	255	291
	363	36	73	109	145	182	218	254	290
	362	36	72	109	145	181	217	253	290
	361	36	72	108	144	181	217	253	289
	360	36	72	108	144	180	216	252	288
	359	36	72	108	144	180	215	251	287
	358	36	72	107	143	179	215	251	286
	357	36	71	107	143	179	214	250	286
	356	36	71	107	142	178	214	249	285
	355	36	71	107	142	178	213	249	284
	354	35	71	106	142	177	212	248	283
	353	35	71	106	141	177	212	247	282
	352	35	70	106	141	176	211	246	282
	351	35	70	105	140	176	211	246	281
	350	35	70	105	140	175	210	245	280
	349	35	70	105	140	175	209	244	279
	348	35	70	104	139	174	209	244	278
	347	35	69	104	139	174	208	243	278
	Diff.	1	2	3	4	5	6	7	8

N	0	1	2	3	4	5	6	7	8	9	Dif.
125	096910	7257	7604	7951	8298	8644	8990	9335	9681	*0026	346
126	100371	0715	1059	1403	1747	2091	2434	2777	3119	3462	343
127	3804	4146	4487	4828	5169	5510	5851	6191	6531	6871	341
128	7210	7549	7888	8227	8565	8903	9241	9579	9916	*0253	338
129	110590	0926	1263	1599	1934	2270	2605	2940	3275	3609	335
130	113943	4277	4611	4944	5278	5611	5943	6276	6608	6940	333
131	7271	7603	7934	8265	8595	8926	9256	9586	9915	*0245	330
132	120574	0903	1231	1560	1888	2216	2544	2871	3198	3525	328
133	3852	4178	4504	4830	5156	5481	5806	6131	6456	6781	325
134	7105	7429	7753	8076	8399	8722	9045	9368	9690	*0012	323
135	130334	0655	0977	1298	1619	1939	2260	2580	2900	3219	321
136	3539	3858	4177	4496	4814	5133	5451	5769	6086	6403	318
137	6721	7037	7354	7671	7987	8303	8618	8934	9249	9564	316
138	9879	*0194	*0508	*0822	*1136	*1450	*1763	*2076	*2389	*2702	314
139	143015	3327	3639	3951	4263	4574	4885	5196	5507	5818	311

N.	Dif.	1	2	3	4	5	6	7	8	9	Dif.
PROPORTIONAL PARTS	347	35	69	104	139	174	208	243	278	312	347
	346	35	69	104	138	173	208	242	277	311	346
	345	35	69	104	138	173	207	242	276	311	345
	344	34	69	103	138	172	206	241	275	310	344
	343	34	69	103	137	172	206	240	274	309	343
	342	34	68	103	137	171	205	239	274	308	342
	341	34	68	102	136	171	205	239	273	307	341
	340	34	68	102	136	170	204	238	272	306	340
	339	34	68	102	136	170	203	237	271	305	339
	338	34	68	101	135	169	203	237	270	304	338
	337	34	67	101	135	169	202	236	270	303	337
	336	34	67	101	134	168	202	235	269	302	336
	335	34	67	101	134	168	201	235	268	302	335
	334	33	67	100	134	167	200	234	267	301	334
	333	33	67	100	133	167	200	233	266	300	333
	332	33	66	100	133	166	199	232	266	299	332
	331	33	66	99	132	166	199	232	265	298	331
	330	33	66	99	132	165	198	231	264	297	330
	329	33	66	99	132	165	197	230	263	296	329
	328	33	66	98	131	164	197	230	262	295	328
	327	33	65	98	131	164	196	229	262	294	327
	326	33	65	98	130	163	196	228	261	293	326
	325	33	65	98	130	163	195	228	260	293	325
	324	32	65	97	130	162	194	227	259	292	324
	323	32	65	97	129	162	194	226	258	291	323
	322	32	64	97	129	161	193	225	258	290	322
	321	32	64	96	128	161	193	225	257	289	321
	320	32	64	96	128	160	192	224	256	288	320
	9	32	64	96	128	160	191	223	255	287	319
	8	32	64	95	127	159	191	223	254	286	318
	7	32	63	95	127	159	190	222	254	285	317
	6	32	63	95	126	158	190	221	253	284	316
	5	32	63	95	126	158	189	221	252	284	315
	4	31	63	94	126	157	188	220	251	283	314
	3	31	63	94	125	157	188	219	250	282	313
	2	31	62	94	125	156	187	218	250	281	312
	1	31	62	93	124	156	187	218	249	280	311
	0	31	62	93	124	155	186	217	248	279	310
	9	31	62	93	124	155	185	216	247	278	309
	8	31	62	92	123	154	185	216	246	277	308
	7	31	61	92	123	154	184	215	246	276	307
	ff	1	2	3	4	5	6	7	8	9	Dif.

TABLE XII.—LOGARITHMS OF NUMBERS.

N.	0	1	2	3	4	5	6	7	8
140	146128	6438	6748	7058	7367	7676	7985	8294	8603
141	9219	9527	9835	*0142	*0449	*0756	*1063	*1370	*1676
142	152288	2594	2900	3205	3510	3815	4120	4424	4728
143	5336	5640	5943	6246	6549	6852	7154	7457	7759
144	8362	8664	8965	9266	9567	9868	*0168	*0469	*0769
145	161368	1667	1967	2266	2564	2863	3161	3460	3758
146	4353	4650	4947	5244	5541	5838	6134	6430	6726
147	7317	7613	7908	8203	8497	8792	9086	9380	9674
148	170262	0555	0848	1141	1434	1726	2019	2311	2603
149	3186	3478	3769	4060	4351	4641	4932	5222	5512
150	176091	6381	6670	6959	7248	7536	7825	8113	8401
151	8977	9264	9552	9839	*0126	*0413	*0699	*0986	*1272
152	181844	2129	2415	2700	2985	3270	3555	3839	4123
153	4691	4975	5259	5542	5825	6108	6391	6674	6956
154	7521	7803	8084	8366	8647	8928	9209	9490	9771
155	190332	0612	0892	1171	1451	1730	2010	2289	2567
156	3125	3403	3681	3959	4237	4514	4792	5069	5346
157	5900	6176	6453	6729	7005	7281	7556	7832	8107
158	8657	8932	9206	9481	9755	*0029	*0303	*0577	*0850
159	201397	1670	1943	2216	2488	2761	3033	3305	3577

N.	Diff.	1	2	[illegible]	4	5	6	7	8
PROPORTIONAL PARTS	306	31	61	92	122	153	184	214	245
	305	31	61	92	122	153	183	214	244
	304	30	61	91	122	152	182	213	243
	303	30	61	91	121	152	182	212	242
	302	30	60	91	121	151	181	211	242
	301	30	60	90	120	151	181	211	241
	300	30	60	90	120	150	180	210	240
	299	30	60	90	120	150	179	209	239
	298	30	60	89	119	149	179	209	238
	297	30	59	89	119	149	178	208	238
	296	30	59	89	118	148	178	207	237
	295	30	59	89	118	148	177	207	236
	294	29	59	88	118	147	176	206	235
	293	29	59	88	117	147	176	205	234
	292	29	58	88	117	146	175	204	234
	291	29	58	87	116	146	175	204	233
	290	29	58	87	116	145	174	203	232
	289	29	58	87	116	145	173	202	231
	288	29	58	86	115	144	173	202	230
	287	29	57	86	115	144	172	201	230
	286	29	57	86	114	143	172	200	229
	285	29	57	86	114	143	171	200	228
	284	28	57	85	114	142	170	199	227
	283	[illegible]	57	85	113	142	170	198	226
	282	28	56	85	113	141	169	197	226
	281	28	56	84	112	141	169	197	225
	280	28	56	84	112	140	168	196	224
	279	28	56	84	112	140	167	195	223
	278	28	56	83	111	139	167	195	222
	277	28	55	83	111	139	166	194	222
	276	28	55	83	110	138	166	193	221
	275	28	55	83	110	138	165	193	220
	274	27	55	82	110	137	164	192	219
	273	27	55	82	109	137	164	191	218
	272	27	54	82	109	136	163	190	218
	271	27	54	81	108	136	163	190	217
	Diff.	1	2	3	4	5	6	7	8

N.	0	1	2	3	4	5	6	7	8	9
160	204120	4391	4663	4934	5204	5475	5746	6016	6286	6556
161	6826	7096	7365	7634	7904	8173	8441	8710	8979	9247
162	9515	9783	*0051	*0319	*0586	*0853	*1121	*1388	*1654	*1921
163	212188	2454	2720	2986	3252	3518	3783	4049	4314	4579
164	4844	5109	5373	5638	5902	6166	6430	6694	6957	7221
165	217484	7747	8010	8273	8536	8798	9060	9323	9585	9846
166	220108	0370	0631	0892	1153	1414	1675	1936	2196	2456
167	2716	2976	3236	3496	3755	4015	4274	4533	4792	5051
168	5309	5568	5826	6084	6342	6600	6858	7115	7372	7630
169	7887	8144	8400	8657	8913	9170	9426	9682	9938	*0193
170	230449	0704	0960	1215	1470	1724	1979	2234	2488	2742
171	2996	3250	3504	3757	4011	4264	4517	4770	5023	5276
172	5528	5781	6033	6285	6537	6789	7041	7292	7544	7795
173	8046	8297	8548	8799	9049	9299	9550	9800	*0050	*0300
174	240549	0799	1048	1297	1546	1795	2044	2293	2541	2790
175	243038	3286	3534	3782	4030	4277	4525	4772	5019	5266
176	5513	5759	6006	6252	6499	6745	6991	7237	7482	7728
177	7973	8219	8464	8709	8954	9198	9443	9687	9932	*0176
178	250420	0664	0908	1151	1395	1638	1881	2125	2368	2610
179	2853	3096	3338	3580	3822	4064	4306	4548	4790	5031

N.	Diff.	1	2	[illegible]	4	5	6	7	8	9
PROPORTIONAL PARTS	272	27	[illegible]	82	109	136	163	190	218	245
	271	27	54	81	108	136	163	190	217	244
	270	27	54	81	108	135	162	189	216	243
	269	27	54	81	108	135	161	188	215	242
	268	27	54	80	107	134	161	188	214	241
	267	27	53	80	107	134	160	187	214	240
	266	27	53	80	106	133	160	186	213	239
	265	27	53	80	106	133	159	186	212	239
	264	26	53	79	106	132	158	185	211	238
	263	26	53	79	105	132	158	184	210	237
	262	26	52	79	105	131	157	183	210	236
	261	26	52	78	104	131	157	183	209	235
	260	26	52	78	104	130	156	182	208	234
	259	26	52	78	104	130	155	181	207	233
	258	26	52	77	103	129	155	181	206	232
	257	26	51	77	103	129	154	180	206	231
	256	26	51	77	102	128	154	179	205	230
	255	26	51	77	102	128	153	179	204	230
	254	25	51	76	102	127	152	178	203	229
	253	25	51	76	101	127	152	177	202	228
	252	25	50	76	101	126	151	176	202	227
	251	25	50	75	100	126	151	176	201	226
	250	25	50	75	100	125	150	175	200	225
	249	25	50	75	100	125	149	174	199	224
	248	25	50	74	99	124	149	174	198	223
	247	25	49	74	99	124	148	173	198	222
	246	25	49	74	98	123	148	172	197	221
	245	25	49	74	98	123	147	172	196	221
	244	24	49	73	98	122	146	171	195	220
	243	24	49	73	97	122	146	170	194	219
	242	24	48	73	97	121	145	169	194	218
	241	24	48	72	96	121	145	169	193	217
	240	24	48	72	96	120	144	168	192	216
	Diff.	1	2	3	4	5	6	7	8	9

TABLE XII.—LOGARITHMS OF NUMBERS.

				3	4	5	6	7	8	9	Diff.
180	255273	5514	5755	5996	6237	6477	6718	6958	7198	7439	241
181	7679	7918	8158	8398	8637	8877	9116	9355	9594	9833	239
182	260071	0310	0548	0787	1025	1263	1501	1739	1976	2214	238
183	2451	2688	2925	3162	3399	3636	3873	4109	4346	4582	237
184	4818	5054	5290	5525	5761	5996	6232	6467	6702	6937	235
											234
											233
											232
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Diff.
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PROPORTI

N.	0	1	2	3	4	5	6	7	8	9	Diff.
205	311754	1966	2177	2389	2600	2812	3023	3234	3445	3656	211
206	3867	4078	4289	4499	4710	4920	5130	5340	5551	5760	210
207	5970	6180	6390	6599	6809	7018	7227	7436	7646	7854	209
208	8063	8272	8481	8689	8898	9106	9314	9522	9730	9938	208
209	320146	0354	0562	0769	0977	1184	1391	1598	1805	2012	207
210	322219	2426	2633	2839	3046	3252	3458	3665	3871	4077	206
211	4282	4488	4694	4899	5105	5310	5516	5721	5926	6131	205
212	6336	6541	6745	6950	7155	7359	7563	7767	7972	8176	204
213	8380	8583	8787	8991	9194	9398	9601	9805	*0008	*0211	203
214	330414	0617	0819	1022	1225	1427	1630	1832	2034	2236	202
215	332438	2640	2842	3044	3246	3447	3649	3850	4051	4253	202
216	4454	4655	4856	5057	5257	5458	5658	5859	6059	6260	201
217	6460	6660	6860	7060	7260	7459	7659	7858	8058	8257	200
218	8456	8656	8855	9054	9253	9451	9650	9849	*0047	*0246	199
219	340444	0642	0841	1039	1237	1435	1632	1830	2028	2225	198
220	342423	2620	2817	3014	3212	3409	3606	3802	3999	4196	197
221	4392	4589	4785	4981	5178	5374	5570	5766	5962	6157	196
222	6353	6549	6744	6939	7135	7330	7525	7720	7915	8110	195
223	8305	8500	8694	8889	9083	9278	9472	9666	9860	*0054	194
224	350248	0442	0636	0829	1023	1216	1410	1603	1796	1989	193
225	352183	2375	2568	2761	2954	3147	3339	3532	3724	3916	193
226	4108	4301	4493	4685	4876	5068	5260	5452	5643	5834	192
227	6026	6217	6408	6599	6790	6981	7172	7363	7554	7744	191
228	7935	8125	8316	8506	8696	8886	9076	9266	9456	9646	190
229	9835	*0025	*0215	*0404	*0593	*0783	*0972	*1161	*1350	*1539	189
230	361728	1917	2105	2294	2482	2671	2859	3048	3236	3424	188
231	3612	3800	3988	4176	4363	4551	4739	4926	5113	5301	188
232	5488	5675	5862	6049	6236	6423	6610	6796	6983	7169	187
233	7356	7542	7729	7915	8101	8287	8473	8659	8845	9030	186
234	9216	9401	9587	9772	9958	*0143	*0328	*0513	*0698	*0883	185

PROPORTIONAL PARTS

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
	212	21	42	64	85	106	127	148	170	191	212
	211	21	42	63	84	106	127	148	169	190	211
	210	21	42	63	84	105	126	147	168	189	210
	209	21	42	63	84	105	125	146	167	188	209
	208	21	42	62	83	104	125	146	166	187	208
	207	21	41	62	83	104	124	145	166	186	207
	206	21	41	62	82	103	124	144	165	185	206
	205	21	41	62	82	103	123	144	164	185	205
	204	20	41	61	82	102	122	143	163	184	204
	203	20	41	61	81	102	122	142	162	183	203
	202	20	40	61	81	101	121	141	162	182	202
	201	20	40	60	80	101	121	141	161	181	201
	200	20	40	60	80	100	120	140	160	180	200
	199	20	40	60	80	100	119	139	159	179	199
	198	20	40	59	79	99	119	139	158	178	198
	197	20	39	59	79	99	118	138	158	177	197
	196	20	39	59	78	98	118	137	157	176	196
	195	20	39	59	78	98	117	137	156	176	195
	194	19	39	58	78	97	116	136	155	175	194
	193	19	39	58	77	97	116	135	154	174	193
	192	19	38	58	77	96	115	134	154	173	192
	191	19	38	57	76	96	115	134	153	172	191
	190	19	38	57	76	95	114	133	152	171	190
	189	19	38	57	76	95	113	132	151	170	189
	188	19	38	56	75	94	113	132	150	169	188
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

N	0	1	2	3	4	5	6	7	8	9	Diff.
235	371068	1253	1437	1622	1806	1991	2175	2360	2544	2728	184
236	2912	3096	3280	3464	3647	3831	4015	4198	4382	4565	184
237	4748	4932	5115	5298	5481	5664	5846	6029	6212	6394	183
238	6577	6759	6942	7124	7306	7488	7670	7852	8034	8216	182
239	8398	8580	8761	8943	9124	9306	9487	9668	9849	*0030	181
240	380211	0392	0573	0754	0934	1115	1296	1476	1656	1837	181
241	2017	2197	2377	2557	2737	2917	3097	3277	3456	3636	180
242	3815	3995	4174	4353	4533	4712	4891	5070	5249	5428	179
243	5606	5785	5964	6142	6321	6499	6677	6856	7034	7212	178
244	7390	7568	7746	7923	8101	8279	8456	8634	8811	8989	178
245	389166	9343	9520	9698	9875	*0051	*0228	*0405	*0582	*0759	177
246	390935	1112	1288	1464	1641	1817	1993	2169	2345	2521	176
247	2697	2873	3048	3224	3400	3575	3751	3926	4101	4277	176
248	4452	4627	4802	4977	5152	5326	5501	5676	5850	6025	175
249	6199	6374	6548	6722	6896	7071	7245	7419	7592	7766	174
250	397940	8114	8287	8461	8634	8808	8981	9154	9328	9501	173
251	9674	9847	*0020	*0192	*0365	*0538	*0711	*0883	*1056	*1228	173
252	401401	1573	1745	1917	2089	2261	2433	2605	2777	2949	172
253	3121	3292	3464	3635	3807	3978	4149	4320	4492	4663	171
254	4834	5005	5176	5346	5517	5688	5858	6029	6199	6370	171
255	406540	6710	6881	7051	7221	7391	7561	7731	7901	8070	170
256	8240	8410	8579	8749	8918	9087	9257	9426	9595	9764	169
257	9933	*0102	*0271	*0440	*0609	*0777	*0946	*1114	*1283	*1451	169
258	411620	1788	1956	2124	2293	2461	2629	2796	2964	3132	168
259	3300	3467	3635	3803	3970	4137	4305	4472	4639	4806	167
260	414973	5140	5307	5474	5641	5808	5974	6141	6308	6474	167
261	6641	6807	6973	7139	7306	7472	7638	7804	7970	8135	166
262	8301	8467	8633	8798	8964	9129	9295	9460	9625	9791	165
263	9956	*0121	*0286	*0451	*0616	*0781	*0945	*1110	*1275	*1439	165
264	421604	1768	1933	2097	2261	2426	2590	2754	2918	3082	164

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PROPORTIONAL PARTS	187	19	37	56	75	94	112	131	150	168	187
	186	19	37	56	74	93	112	130	149	167	186
	185	19	37	56	74	93	111	130	148	167	185
	184	18	37	55	74	92	110	129	147	166	184
	183	18	37	55	73	92	110	128	146	165	183
	182	18	36	55	73	91	109	127	146	164	[illegible]
	181	18	36	54	72	91	109	127	145	163	181
	180	18	36	54	72	90	108	126	144	162	180
	179	18	36	54	72	90	107	125	143	161	179
	178	18	36	53	71	89	107	125	142	160	178
	177	18	35	53	71	89	106	124	142	159	177
	176	18	35	53	70	88	106	123	141	158	176
	175	18	35	53	70	88	105	123	140	158	175
	174	17	35	52	70	87	104	122	139	157	174
	173	17	35	52	69	87	104	121	138	156	173
	172	17	34	52	69	86	103	120	138	155	172
	171	17	34	51	68	86	103	120	137	154	171
	170	17	34	51	68	85	102	119	136	153	170
	169	17	34	51	68	85	101	118	135	152	169
	168	17	34	50	67	84	101	118	134	151	168
	167	17	33	50	67	84	100	117	134	150	167
	166	17	33	50	66	83	100	116	133	149	166
	165	17	33	50	66	83	99	116	132	149	165
	164	16	33	49	66	82	98	115	131	148	164
	Diff.										

N.	0	1	2	3	4	5	6	7	8	9	Diff.
265	423246	3410	3574	3737	3901	4065	4228	4392	4555	4718	164
266	4882	5045	5208	5371	5534	5697	5860	6023	6186	6349	163
267	6511	6674	6836	6999	7161	7324	7486	7648	7811	7973	162
268	8135	8297	8459	8621	8783	8944	9106	9268	9429	9591	162
269	9752	9914	*0075	*0236	*0398	*0559	*0720	*0881	*1042	*1203	161
270	431364	1525	1685	1846	2007	2167	2328	2488	2649	2809	161
271	2969	3130	3290	3450	3610	3770	3930	4090	4249	4409	160
272	4569	4729	4888	5048	5207	5367	5526	5685	5844	6004	159
273	6163	6322	6481	6640	6799	6957	7116	7275	7433	7592	159
274	7751	7909	8067	8226	8384	8542	8701	8859	9017	9175	158
275	439333	9491	9648	9806	9964	*0122	*0279	*0437	*0594	*0752	158
276	440909	1066	1224	1381	1538	1695	1852	2009	2166	2323	157
277	2480	2637	2793	2950	3106	3263	3419	3576	3732	3889	157
278	4045	4201	4357	4513	4669	4825	4981	5137	5293	5449	156
279	5604	5760	5915	6071	6226	6382	6537	6692	6848	7003	155
280	447158	7313	7468	7623	7778	7933	8088	8242	8397	8552	155
281	8706	8861	9015	9170	9324	9478	9633	9787	9941	*0095	154
282	450249	0403	0557	0711	0865	1018	1172	1326	1479	1633	154
283	1786	1940	2093	2247	2400	2553	2706	2859	3012	3165	153
284	3318	3471	3624	3777	3930	4082	4235	4387	4540	4692	153
285	454845	4997	5150	5302	5454	5606	5758	5910	6062	6214	152
286	6366	6518	6670	6821	6973	7125	7276	7428	7579	7731	152
287	7882	8033	8184	8336	8487	8638	8789	8940	9091	9242	151
288	9392	9543	9694	9845	9995	*0146	*0296	*0447	*0597	*0748	151
289	460898	1048	1198	1348	1499	1649	1799	1948	2098	2248	150
290	462398	2548	2697	2847	2997	3146	3296	3445	3594	3744	150
291	3893	4042	4191	4340	4490	4639	4788	4936	5085	5234	149
292	5383	5532	5680	5829	5977	6126	6274	6423	6571	6719	149
293	6868	7016	7164	7312	7460	7608	7756	7904	8052	8200	148
294	8347	8495	8643	8790	8938	9085	9233	9380	9527	9675	148
295	469822	9969	*0116	*0263	*0410	*0557	*0704	*0851	*0998	*1145	147
296	471292	1438	1585	1732	1878	2025	2171	2318	2464	2610	146
297	2756	2903	3049	3195	3341	3487	3633	3779	3925	4071	146
298	4216	4362	4508	4653	4799	4944	5090	5235	5381	5526	146
299	5671	5816	5962	6107	6252	6397	6542	6687	6832	6976	145

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PROPORTIONAL PARTS	164	16	33	49	66	82	98	115	131	148	164
	163	16	33	49	65	82	98	114	130	147	163
	162	16	32	49	65	81	97	113	130	146	162
	161	16	32	48	64	81	97	113	129	145	161
	160	16	32	48	64	80	96	112	128	144	160
	159	16	32	48	64	80	95	111	127	143	159
	158	16	32	47	63	79	95	111	126	142	158
	157	16	31	47	63	79	94	110	126	141	157
	156	16	31	47	62	78	94	109	125	140	156
	155	16	31	47	62	78	93	109	124	140	155
	154	15	31	46	62	77	92	108	123	139	154
	153	15	31	46	61	77	92	107	122	138	153
	152	15	30	46	61	76	91	106	122	137	152
	151	15	30	45	60	76	91	106	121	136	151
	150	15	30	45	60	75	90	105	120	135	150
	149	15	30	45	60	75	89				
	148	15	30	44	59	74	89				
	147	15	29	44	59	74	88				
	146	15	29	44	58	73	38				
			9	44	58	73	87				
			9	43	58	72	86				
			9	43	57	72	86				
				3	4	5	6				

N.	0	1	2	3	4	5	6	7	8	9	Diff.
300	477121	7266	7411	7555	7700	7844	7989	8133	8278	8422	145
301	8566	8711	8855	8999	9143	9287	9431	9575	9719	9863	144
302	480007	0151	0294	0438	0582	0725	0869	1012	1156	1299	144
303	1443	1586	1729	1872	2016	2159	2302	2445	2588	2731	143
304	2874	3016	3159	3302	3445	3587	3730	3872	4015	4157	143
305	484300	4442	4585	4727	4869	5011	5153	5295	5437	5579	142
306	5721	5863	6005	6147	6289	6430	6572	6714	6855	6997	142
307	7138	7280	7421	7563	7704	7845	7986	8127	8269	8410	141
308	8551	8692	8833	8974	9114	9255	9396	9537	9677	9818	141
309	9958	*0099	*0239	*0380	*0520	*0661	*0801	*0941	*1081	*1222	140
310	491362	1502	1642	1782	1922	2062	2201	2341	2481	2621	140
311	2760	2900	3040	3179	3319	3458	3597	3737	3876	4015	139
312	4155	4294	4433	4572	4711	4850	4989	5128	5267	5406	139
313	5544	5683	5822	5960	6099	6238	6376	6515	6653	6791	139
314	6930	7068	7206	7344	7483	7621	7759	7897	8035	8173	138
315	498311	8448	8586	8724	8862	8999	9137	9275	9412	9550	138
316	9687	9824	9962	*0099	*0236	*0374	*0511	*0648	*0785	*0922	137
317	501059	1196	1333	1470	1607	1744	1880	2017	2154	2291	137
318	2427	2564	2700	2837	2973	3109	3246	3382	3518	3655	136
319	3791	3927	4063	4199	4335	4471	4607	4743	4878	5014	136
320	505150	5286	5421	5557	5693	5828	5964	6099	6234	6370	136
321	6505	6640	6776	6911	7046	7181	7316	7451	7586	7721	135
322	7856	7991	8126	8260	8395	8530	8664	8799	8934	9068	135
323	9203	9337	9471	9606	9740	9874	*0009	*0143	*0277	*0411	134
324	510545	0679	0813	0947	1081	1215	1349	1482	1616	1750	134
325	511883	2017	2151	2284	2418	2551	2684	2818	2951	3084	133
326	3218	3351	3484	3617	3750	3883	4016	4149	4282	4415	133
327	4548	4681	4813	4946	5079	5211	5344	5476	5609	5741	133
328	5874	6006	6139	6271	6403	6535	6668	6800	6932	7064	132
329	7196	7328	7460	7592	7724	7855	7987	8119	8251	8382	132
330	518514	8646	8777	8909	9040	9171	9303	9434	9566	9697	131
331	9828	9959	*0090	*0221	*0353	*0484	*0615	*0745	*0876	*1007	131
332	521138	1269	1400	1530	1661	1792	1922	2053	2183	2314	131
333	2444	2575	2705	2835	2966	3096	3226	3356	3486	3616	130
334	3746	3876	4006	4136	4266	4396	4526	4656	4785	4915	130
335	525045	5174	5304	5434	5563	5693	5822	5951	6081	6210	129
336	6339	6469	6598	6727	6856	6985	7114	7243	7372	7501	129
337	7630	7759	7888	8016	8145	8274	8402	8531	8660	8788	129
338	8917	9045	9174	9302	9430	9559	9687	9815	9943	*0072	128
339	530200	0328	0456	0584	0712	0840	0968	1096	1223	1351	128

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PROPORTIONAL PARTS	142	14	28	43	57	71	85	99	114	128	142
	141	14	28	42	56	71	85	99	113	127	141
	140	14	28	42	56	70	84	98	112	126	140
	139	14	28	42	56	70	83	97	111	125	139
	138	14	28	41	55	69	83	97	110	124	138
	137	14	27	41	55	69	82	96	110	123	137
	136	14	27	41	54	68	82	95	109	122	136
	135	14	27	41	54	68	81	95	108	122	135
	134	13	27	40	54	67	80	94	107	121	134
	133	13	27	40	53	67	80	93	106	120	133
	132	13	26	40	53	66	79	92	106	119	132
	131	13	26	39	52	66	79	92	105	118	131
	130	13	26	39	52	65	78	91	104	117	130
	129	13	26	39	52	65	77	90	103	116	129
	128	13	26	38	51	64	77	90	102	115	128
	127	13	25	38	51	64	76	89	102	114	127
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

TABLE XII.—LOGARITHMS OF NUMBERS.

N.	0	1	2	3	4	5	6	7	8	9	Dif.
340	531479	1607	1734	1862	1990	2117	2245	2372	2500	2627	128
341	2754	2882	3009	3136	3264	3391	3518	3645	3772	3899	127
342	4026	4153	4280	4407	4534	4661	4787	4914	5041	5167	127
343	5294	5421	5547	5674	5800	5927	6053	6180	6306	6432	126
344	6558	6685	6811	6937	7063	7189	7315	7441	7567	7693	126
345	537819	7945	8071	8197	8322	8448	8574	8699	8825	8951	126
346	9076	9202	9327	9452	9578	9703	9829	9954	*0079	*0204	125
347	540329	0455	0580	0705	0830	0955	1080	1205	1330	1454	125
348	1579	1704	1829	1953	2078	2203	2327	2452	2576	2701	125
349	2825	2950	3074	3199	3323	3447	3571	3696	3820	3944	124
350	544068	4192	4316	4440	4564	4688	4812	4936	5060	5183	124
351	5307	5431	5555	5678	5802	5925	6049	6172	6296	6419	124
352	6543	6666	6789	6913	7036	7159	7282	7405	7529	7652	123
353	7775	7898	8021	8144	8267	8389	8512	8635	8758	8881	123
354	9003	9126	9249	9371	9494	9616	9739	9861	9984	*0106	123
355	550228	0351	0473	0595	0717	0840	0962	1084	1206	1328	122
356	1450	1572	1694	1816	1938	2060	2181	2303	2425	2547	122
357	2668	2790	2911	3033	3155	3276	3398	3519	3640	3762	121
358	3883	4004	4126	4247	4368	4489	4610	4731	4852	4973	121
359	5094	5215	5336	5457	5578	5699	5820	5940	6061	6182	121
360	556303	6423	6544	6664	6785	6905	7026	7146	7267	7387	120
361	7507	7627	7748	7868	7988	8108	8228	8349	8469	8589	120
362	8709	8829	8948	9068	9188	9308	9428	9548	9667	9787	120
363	9907	*0026	*0146	*0265	*0385	*0504	*0624	*0743	*0863	*0982	119
364	561101	1221	1340	1459	1578	1698	1817	1936	2055	2174	119
365	562293	2412	2531	2650	2769	2887	3006	3125	3244	3362	119
366	3481	3600	3718	3837	3955	4074	4192	4311	4429	4548	119
367	4666	4784	4903	5021	5139	5257	5376	5494	5612	5730	118
368	5848	5966	6084	6202	6320	6437	6555	6673	6791	6909	118
369	7026	7144	7262	7379	7497	7614	7732	7849	7967	8084	118
370	568202	8319	8436	8554	8671	8788	8905	9023	9140	9257	117
371	9374	9491	9608	9725	9842	9959	*0076	*0193	*0309	*0426	117
372	570543	0660	0776	0893	1010	1126	1243	1359	1476	1592	117
373	1709	1825	1942	2058	2174	2291	2407	2523	2639	2755	116
374	2872	2988	3104	3220	3336	3452	3568	3684	3800	3915	116
375	574031	4147	4263	4379	4494	4610	4726	4841	4957	5072	116
376	5188	5303	5419	5534	5650	5765	5880	5996	6111	6226	115
377	6341	6457	6572	6687	6802	6917	7032	7147	7262	7377	115
378	7492	7607	7722	7836	7951	8066	8181	8295	8410	8525	115
379	8639	8754	8868	8983	9097	9212	9326	9441	9555	9669	114

N.	Dif.	1	2	3	4	5	6	7	8	9	Dif.
PROP. PARTS	128	13	26	38	51	64	77	90	102	115	128
	127	13	25	38	51	64	76	89	102	114	127
	126	13	25	38	50	63	76	88	101	113	126
	125	13	25	38	50	63	75	88	100	113	125
	124	12	25	37	50	62	74	87	99	112	124
	123	12	25	37	49	62	74	86	98	111	123
	122	12	24	37	49	61	73	85	98	110	122
	121	12	24	36	48	61	73	85	97	109	121
	120	12	24	36	48	60	72	84	96	108	120
	119	12	24	36	48	60	71	83	95	107	119
	118	12	24	35	47	59	71	83	94	106	118
											117
											116
											Dif.

N.											
380	579784	9898	*0012	*0126	*0241	*0355	*0469	*0583	*0697	*0811	114
381	580925	1039	1153	1267	1381	1495	1608	1722	1836	1950	114
382	2063	2177	2291	2404	2518	2631	2745	2858	2972	3085	114
383	3199	3312	3426	3539	3652	3765	3879	3992	4105	4218	113
384	4331	4444	4557	4670	4783	4896	5009	5122	5235	5348	113
385	585461	5574	5686	5799	5912	6024	6137	6250	6362	6475	113
386	6587	6700	6812	6925	7037	7149	7262	7374	7486	7599	112
387	7711	7823	7935	8047	8160	8272	8384	8496	8608	8720	112
388	8832	8944	9056	9167	9279	9391	9503	9615	9726	9838	112
389	9950	*0061	*0173	*0284	*0396	*0507	*0619	*0730	*0842	*0953	112
390	591065	1176	1287	1399	1510	1621	1732	1843	1955	2066	111
391	2177	2288	2399	2510	2621	2732	2843	2954	3064	3175	111
392	3286	3397	3508	3618	3729	3840	3950	4061	4171	4282	111
393	4393	4503	4614	4724	4834	4945	5055	5165	5276	5386	110
394	5496	5606	5717	5827	5937	6047	6157	6267	6377	6487	110
395	596597	6707	6817	6927	7037	7146	7256	7366	7476	7586	110
396	7695	7805	7914	8024	8134	8243	8353	8462	8572	8681	110
397	8791	8900	9009	9119	9228	9337	9446	9556	9665	9774	109
398	9883	9992	*0101	*0210	*0319	*0428	*0537	*0646	*0755	*0864	109
399	600973	1082	1191	1299	1408	1517	1625	1734	1843	1951	109
400	602060	2169	2277	2386	2494	2603	2711	2819	2928	3036	108
401	3144	3253	3361	3469	3577	3686	3794	3902	4010	4118	108
402	4226	4334	4442	4550	4658	4766	4874	4982	5089	5197	108
403	5305	5413	5521	5628	5736	5844	5951	6059	6166	6274	108
404	6381	6489	6596	6704	6811	6919	7026	7133	7241	7348	107
405	607455	7562	7669	7777	7884	7991	8098	8205	8312	8419	107
406	8526	8633	8740	8847	8954	9061	9167	9274	9381	9488	107
407	9594	9701	9808	9914	*0021	*0128	*0234	*0341	*0447	*0554	107
408	610660	0767	0873	0979	1086	1192	1298	1405	1511	1617	106
409	1723	1829	1936	2042	2148	2254	2360	2466	2572	2678	106
410	612784	2890	2996	3102	3207	3313	3419	3525	3630	3736	106
411	3842	3947	4053	4159	4264	4370	4475	4581	4686	4792	106
412	4897	5003	5108	5213	5319	5424	5529	5634	5740	5845	105
413	5950	6055	6160	6265	6370	6476	6581	6686	6790	6895	105
414	7000	7105	7210	7315	7420	7525	7629	7734	7839	7943	105
415	618048	8153	8257	8362	8466	8571	8676	8780	8884	8989	105
416	9093	9198	9302	9406	9511	9615	9719	9824	9928	*0032	104
417	620136	0240	0344	0448	0552	0656	0760	0864	0968	1072	104
418	1176	1280	1384	1488	1592	1695	1799	1903	2007	2110	104
419	2214	2318	2421	2525	2628	2732	2835	2939	3042	3146	104

PROP. PARTS	Diff.	1	2	3	4	5	6	7	8	9	Diff.
	115	12	23	35	46	58	69	81	92	104	115
	114	11	23	34	46	57	68	80	91	103	114
	113	11	23	34	45	57	68	79	90	102	113
	112	11	22	34	45	56	67	78	90	101	112
	111	11	22	33	44	56	67	78	89	100	111
	110	11	22	33	44	55	66	77	88	99	110
	109	11	22	33	44	55	65	76	87	98	109
	108	11	22	32	43	54	65	76	86	97	108
	107	11	21	32	43	54	64	75	86	96	107
	106	11	21	32	42	53	64	74	85	95	106
	105	11	21	32	42	53	63	74	84	95	105
	104	10	21	31	42	52	62	73	83	94	104
	103	10	21	31	41	52	62	72	82	93	103

N	0	1	2	3	4	5	6	7	8	9	Dif.
420	623249	3353	3456	3559	3663	3766	3869	3973	4076	4179	103
421	4282	4385	4488	4591	4695	4798	4901	5004	5107	5210	103
422	5312	5415	5518	5621	5724	5827	5929	6032	6135	6238	103
423	6340	6443	6546	6648	6751	6853	6956	7058	7161	7263	103
424	7366	7468	7571	7673	7775	7878	7980	8082	8185	8287	102
425	628389	8491	8593	8695	8797	8900	9002	9104	9206	9308	102
426	9410	9512	9613	9715	9817	9919	*0021	*0123	*0224	*0326	102
427	630428	0530	0631	0733	0835	0936	1038	1139	1241	1342	102
428	1444	1545	1647	1748	1849	1951	2052	2153	2255	2356	101
429	2457	2559	2660	2761	2862	2963	3064	3165	3266	3367	101
430	633468	3569	3670	3771	3872	3973	4074	4175	4276	4376	101
431	4477	4578	4679	4779	4880	4981	5081	5182	5283	5383	101
432	5484	5584	5685	5785	5886	5986	6087	6187	6287	6388	100
433	6488	6588	6688	6789	6889	6989	7089	7189	7290	7390	100
434	7490	7590	7690	7790	7890	7990	8090	8190	8290	8389	100
435	638489	8589	8689	8789	8888	8988	9088	9188	9287	9387	100
436	9486	9586	9686	9785	9885	9984	*0084	*0183	*0283	*0382	99
437	640481	0581	0680	0779	0879	0978	1077	1177	1276	1375	99
438	1474	1573	1672	1771	1871	1970	2069	2168	2267	2366	99
439	2465	2563	2662	2761	2860	2959	3058	3156	3255	3354	99
440	643453	3551	3650	3749	3847	3946	4044	4143	4242	4340	98
441	4439	4537	4636	4734	4832	4931	5029	5127	5226	5324	98
442	5422	5521	5619	5717	5815	5913	6011	6110	6208	6306	98
443	6404	6502	6600	6698	6796	6894	6992	7089	7187	7285	98
444	7383	7481	7579	7676	7774	7872	7969	8067	8165	8262	98
445	648360	8458	8555	8653	8750	8848	8945	9043	9140	9237	97
446	9335	9432	9530	9627	9724	9821	9919	*0016	*0113	*0210	97
447	650308	0405	0502	0599	0696	0793	0890	0987	1084	1181	97
448	1278	1375	1472	1569	1666	1762	1859	1956	2053	2150	97
449	2246	2343	2440	2536	2633	2730	2826	2923	3019	3116	97
450	653213	3309	3405	3502	3598	3695	3791	3888	3984	4080	96
451	4177	4273	4369	4465	4562	4658	4754	4850	4946	5042	96
452	5138	5235	5331	5427	5523	5619	5715	5810	5906	6002	96
453	6098	6194	6290	6386	6482	6577	6673	6769	6864	6960	96
454	7056	7152	7247	7343	7438	7534	7629	7725	7820	7916	96
455	658011	8107	8202	8298	8393	8488	8584	8679	8774	8870	95
456	8965	9060	9155	9250	9346	9441	9536	9631	9726	9821	95
457	9916	*0011	*0106	*0201	*0296	*0391	*0486	*0581	*0676	*0771	95
458	660865	0960	1055	1150	1245	1339	1434	1529	1623	1718	95
459	1813	1907	2002	2096	2191	2286	2380	2475	2569	2663	95
460	662758	2852	2947	3041	3135	3230	3324	3418	3512	3607	94
461	3701	3795	3889	3983	4078	4172	4266	4360	4454	4548	94
462	4642	4736	4830	4924	5018	5112	5206	5299	5393	5487	94
463	5581	5675	5769	5862	5956	6050	6143	6237	6331	6424	94
464	6518	6612	6705	6799	6892	6986	7079	7173	7266	7360	94

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PARTS	104	10	21	31	42	52	62	73	83	94	104
	103	10	21	31	41	52	62	72	82	93	103
	102	10	20	31	41	51	61	71	82	92	102
	101	10	20	30	40	51	61	71	81	91	101
	100	10	20	30	40	50	60	70	80	90	100
									79	89	99
									78	88	98
									78	87	97
									77	86	96
									76	86	95
									8	9	Dif.

N.	0	1	2	3	4	5	6	7	8	9	Diff.
465	667453	7546	7640	7733	7826	7920	8013	8106	8199	8293	93
466	8386	8479	8572	8665	8759	8852	8945	9038	9131	9224	93
467	9317	9410	9503	9596	9689	9782	9875	9967	*0060	*0153	93
468	670246	0339	0431	0524	0617	0710	0802	0895	0988	1080	93
469	1173	1265	1358	1451	1543	1636	1728	1821	1913	2005	93
470	672098	2190	2283	2375	2467	2560	2652	2744	2836	2929	92
471	3021	3113	3205	3297	3390	3482	3574	3666	3758	3850	92
472	3942	4034	4126	4218	4310	4402	4494	4586	4677	4769	92
473	4861	4953	5045	5137	5228	5320	5412	5503	5595	5687	92
474	5778	5870	5962	6053	6145	6236	6328	6419	6511	6602	92
475	676694	6785	6876	6968	7059	7151	7242	7333	7424	7516	91
476	7607	7698	7789	7881	7972	8063	8154	8245	8336	8427	91
477	8518	8609	8700	8791	8882	8973	9064	9155	9246	9337	91
478	9428	9519	9610	9700	9791	9882	9973	*0063	*0154	*0245	91
479	680336	0426	0517	0607	0698	0789	0879	0970	1060	1151	91
480	681241	1332	1422	1513	1603	1693	1784	1874	1964	2055	90
481	2145	2235	2326	2416	2506	2596	2686	2777	2867	2957	90
482	3047	3137	3227	3317	3407	3497	3587	3677	3767	3857	90
483	3947	4037	4127	4217	4307	4396	4486	4576	4666	4756	90
484	4845	4935	5025	5114	5204	5294	5383	5473	5563	5652	90
485	685742	5831	5921	6010	6100	6189	6279	6368	6458	6547	89
486	6636	6726	6815	6904	6994	7083	7172	7261	7351	7440	89
487	7529	7618	7707	7796	7886	7975	8064	8153	8242	8331	89
488	8420	8509	8598	8687	8776	8865	8953	9042	9131	9220	89
489	9309	9398	9486	9575	9664	9753	9841	9930	*0019	*0107	89
490	690196	0285	0373	0462	0550	0639	0728	0816	0905	0993	89
491	1081	1170	1258	1347	1435	1524	1612	1700	1789	1877	88
492	1965	2053	2142	2230	2318	2406	2494	2583	2671	2759	88
493	2847	2935	3023	3111	3199	3287	3375	3463	3551	3639	88
494	3727	3815	3903	3991	4078	4166	4254	4342	4430	4517	88
495	694605	4693	4781	4868	4956	5044	5131	5219	5307	5394	88
496	5482	5569	5657	5744	5832	5919	6007	6094	6182	6269	87
497	6356	6444	6531	6618	6706	6793	6880	6968	7055	7142	87
498	7229	7317	7404	7491	7578	7665	7752	7839	7926	8014	87
499	8101	8188	8275	8362	8449	8535	8622	8709	8796	8883	87
500	698970	9057	9144	9231	9317	9404	9491	9578	9664	9751	87
501	9838	9924	*0011	*0098	*0184	*0271	*0358	*0444	*0531	*0617	87
502	700704	0790	0877	0963	1050	1136	1222	1309	1395	1482	86
503	1568	1654	1741	1827	1913	1999	2086	2172	2258	2344	86
504	2431	2517	2603	2689	2775	2861	2947	3033	3119	3205	86
505	703291	3377	3463	3549	3635	3721	3807	3893	3979	4065	86
506	4151	4236	4322	4408	4494	4579	4665	4751	4837	4922	86
507	5008	5094	5179	5265	5350	5436	5522	5607	5693	5778	86
508	5864	5949	6035	6120	6206	6291	6376	6462	6547	6632	85
509	6718	6803	6888	6974	7059	7144	7229	7315	7400	7485	85

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PROP. PARTS	94	9	19	28	38	47	56	66	75	85	94
	93	9	19	28	37	47	56	65	74	84	93
	92	9	18	28	37	46	55	64	74	83	92
	91	9	18	27	36	46	55	64	73	82	91
	90	9	18	27	36	45	54	63	72	81	90
	89	9	18	27	36	45	53	62	71	80	89
	88	9	18	26	35	44	53	62	70	79	88
	87	9	17	26	35	44	52	61	70	78	87
	86	9	17	26	34	43	52	60	69	77	86
	85	9	17	26	34	43	51	60	68	77	85
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

N.	0	1	2	3	4	5	6	7	8	9	Dif.
510	707570	7655	7740	7826	7911	7996	8081	8166	8251	8336	85
511	8421	8506	8591	8676	8761	8846	8931	9015	9100	9185	85
512	9270	9355	9440	9524	9609	9694	9779	9863	9948	*0033	85
513	710117	0202	0287	0371	0456	0540	0625	0710	0794	0879	85
514	0963	1048	1132	1217	1301	1385	1470	1554	1639	1723	84
515	711807	1892	1976	2060	2144	2229	2313	2397	2481	2566	84
516	2650	2734	2818	2902	2986	3070	3154	3238	3323	3407	84
517	3491	3575	3659	3742	3826	3910	3994	4078	4162	4246	84
518	4330	4414	4497	4581	4665	4749	4833	4916	5000	5084	84
519	5167	5251	5335	5418	5502	5586	5669	5753	5836	5920	84
520	716003	6087	6170	6254	6337	6421	6504	6588	6671	6754	83
521	6838	6921	7004	7088	7171	7254	7338	7421	7504	7587	83
522	7671	7754	7837	7920	8003	8086	8169	8253	8336	8419	83
523	8502	8585	8668	8751	8834	8917	9000	9083	9165	9248	83
524	9331	9414	9497	9580	9663	9745	9828	9911	9994	*0077	83
525	720159	0242	0325	0407	0490	0573	0655	0738	0821	0903	83
526	0986	1068	1151	1233	1316	1398	1481	1563	1646	1728	82
527	1811	1893	1975	2058	2140	2222	2305	2387	2469	2552	82
528	2634	2716	2798	2881	2963	3045	3127	3209	3291	3374	82
529	3456	3538	3620	3702	3784	3866	3948	4030	4112	4194	82
530	724276	4358	4440	4522	4604	4685	4767	4849	4931	5013	82
531	5095	5176	5258	5340	5422	5503	5585	5667	5748	5830	82
532	5912	5993	6075	6156	6238	6320	6401	6483	6564	6646	82
533	6727	6809	6890	6972	7053	7134	7216	7297	7379	7460	81
534	7541	7623	7704	7785	7866	7948	8029	8110	8191	8273	81
535	728354	8435	8516	8597	8678	8759	8841	8922	9003	9084	81
536	9165	9246	9327	9408	9489	9570	9651	9732	9813	9893	81
537	9974	*0055	*0136	*0217	*0298	*0378	*0459	*0540	*0621	*0702	81
538	730782	0863	0944	1024	1105	1186	1266	1347	1428	1508	81
539	1589	1669	1750	1830	1911	1991	2072	2152	2233	2313	81
540	732394	2474	2555	2635	2715	2796	2876	2956	3037	3117	80
541	3197	3278	3358	3438	3518	3598	3679	3759	3839	3919	80
542	3999	4079	4160	4240	4320	4400	4480	4560	4640	4720	80
543	4800	4880	4960	5040	5120	5200	5279	5359	5439	5519	80
544	5599	5679	5759	5838	5918	5998	6078	6157	6237	6317	80
545	736397	6476	6556	6635	6715	6795	6874	6954	7034	7113	80
546	7193	7272	7352	7431	7511	7590	7670	7749	7829	7908	79
547	7987	8067	8146	8225	8305	8384	8463	8543	8622	8701	79
548	8781	8860	8939	9018	9097	9177	9256	9335	9414	9493	79
549	9572	9651	9731	9810	9889	9968	*0047	*0126	*0205	*0284	79
550	740363	0442	0521	0600	0678	0757	0836	0915	0994	1073	79
551	1152	1230	1309	1388	1467	1546	1624	1703	1782	1860	79
552	1939	2018	2096	2175	2254	2332	2411	2489	2568	2647	79
553	2725	2804	2882	2961	3039	3118	3196	3275	3353	3431	78
554	3510	3588	3667	3745	3823	3902	3980	4058	4136	4215	78
N.	Diff.	1	2	3	4	5	6	7	8	9	Dif.

	4	5	6	7	8	9	Dif.
6	34	43	52	60	69	77	86
6	34	43	51	60	68	77	85
5	34	42	50	59	67	76	84
5	33	42	50	58	66	75	83
5	33	41	49	57	66	74	82
4	32	41	49	57	65	73	81
4	32	40	48	56	64	72	80
4	32	40	47	55	63	71	79

N.	0	1	2	3	4	5	6	7	8	9	Dif.
555	744293	4371	4449	4528	4606	4684	4762	4840	4919	4997	78
556	5075	5153	5231	5309	5387	5465	5543	5621	5699	5777	78
557	5855	5933	6011	6089	6167	6245	6323	6401	6479	6556	78
558	6634	6712	6790	6868	6945	7023	7101	7179	7256	7334	78
559	7412	7489	7567	7645	7722	7800	7878	7955	8033	8110	78
560	748188	8266	8343	8421	8498	8576	8653	8731	8808	8885	77
561	8963	9040	9118	9195	9272	9350	9427	9504	9582	9659	77
562	9736	9814	9891	9968	*0045	*0123	*0200	*0277	*0354	*0431	77
563	750508	0586	0663	0740	0817	0894	0971	1048	1125	1202	77
564	1279	1356	1433	1510	1587	1664	1741	1818	1895	1972	77
565	752048	2125	2202	2279	2356	2433	2509	2586	2663	2740	77
566	2816	2893	2970	3047	3123	3200	3277	3353	3430	3506	77
567	3583	3660	3736	3813	3889	3966	4042	4119	4195	4272	77
568	4348	4425	4501	4578	4654	4730	4807	4883	4960	5036	76
569	5112	5189	5265	5341	5417	5494	5570	5646	5722	5799	76
570	755875	5951	6027	6103	6180	6256	6332	6408	6484	6560	76
571	6636	6712	6788	6864	6940	7016	7092	7168	7244	7320	76
572	7396	7472	7548	7624	7700	7775	7851	7927	8003	8079	76
573	8155	8230	8306	8382	8458	8533	8609	8685	8761	8836	76
574	8912	8988	9063	9139	9214	9290	9366	9441	9517	9592	76
575	759668	9743	9819	9894	9970	*0045	*0121	*0196	*0272	*0347	75
576	760422	0498	0573	0649	0724	0799	0875	0950	1025	1101	75
577	1176	1251	1326	1402	1477	1552	1627	1702	1778	1853	75
578	1928	2003	2078	2153	2228	2303	2378	2453	2529	2604	75
579	2679	2754	2829	2904	2978	3053	3128	3203	3278	3353	75
580	763428	3503	3578	3653	3727	3802	3877	3952	4027	4101	75
581	4176	4251	4326	4400	4475	4550	4624	4699	4774	4848	75
582	4923	4998	5072	5147	5221	5296	5370	5445	5520	5594	75
583	5669	5743	5818	5892	5966	6041	6115	6190	6264	6338	74
584	6413	6487	6562	6636	6710	6785	6859	6933	7007	7082	74
585	767156	7230	7304	7379	7453	7527	7601	7675	7749	7823	74
586	7898	7972	8046	8120	8194	8268	8342	8416	8490	8564	74
587	8638	8712	8786	8860	8934	9008	9082	9156	9230	9303	74
588	9377	9451	9525	9599	9673	9746	9820	9894	9968	*0042	74
589	770115	0189	0263	0336	0410	0484	0557	0631	0705	0778	74
590	770852	0926	0999	1073	1146	1220	1293	1367	1440	1514	74
591	1587	1661	1734	1808	1881	1955	2028	2102	2175	2248	73
592	2322	2395	2468	2542	2615	2688	2762	2835	2908	2981	73
593	3055	3128	3201	3274	3348	3421	3494	3567	3640	3713	73
594	3786	3860	3933	4006	4079	4152	4225	4298	4371	4444	73
595	774517	4590	4663	4736	4809	4882	4955	5028	5100	5173	73
596	5246	5319	5392	5465	5538	5610	5683	5756	5829	5902	73
597	5974	6047	6120	6193	6265	6338	6411	6483	6556	6629	73
598	6701	6774	6846	6919	6992	7064	7137	7209	7282	7354	73
599	7427	7499	7572	7644	7717	7789	7862	7934	8006	8079	72

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PRO. PARTS	78	8	16	23	31	39	47	55	62	70	78
	77	8	15	23	31	39	46	54	62	69	77
	76	8	15	23	30	38	46	53	61	68	76
	75	8	15	23	30	38	[illegible]	[illegible]	60	68	75
	74	7	15	22	30	37	[illegible]	52	59	67	74
	73	7	15	22	29	37	44	51	58	66	73
	72	7	14	22	29	36	43	50	58	65	72

N.	0	1	2	3	4	5	6	7	8	9	Diff.
600	778151	8224	8296	8368	8441	8513	8585	8658	8730	8802	72
601	8874	8947	9019	9091	9163	9236	9308	9380	9452	9524	72
602	9596	9669	9741	9813	9885	9957	*0029	*0101	*0173	*0245	72
603	780317	0389	0461	0533	0605	0677	0749	0821	0893	0965	72
604	1037	1109	1181	1253	1324	1396	1468	1540	1612	1684	72
605	781755	1827	1899	1971	2042	2114	2186	2258	2329	2401	72
606	2473	2544	2616	2688	2759	2831	2902	2974	3046	3117	72
607	3189	3260	3332	3403	3475	3546	3618	3689	3761	3832	71
608	3904	3975	4046	4118	4189	4261	4332	4403	4475	4546	71
609	4617	4689	4760	4831	4902	4974	5045	5116	5187	5259	71
610	785330	5401	5472	5543	5615	5686	5757	5828	5899	5970	71
611	6041	6112	6183	6254	6325	6396	6467	6538	6609	6680	71
612	6751	6822	6893	6964	7035	7106	7177	7248	7319	7390	71
613	7460	7531	7602	7673	7744	7815	7885	7956	8027	8098	71
614	8168	8239	8310	8381	8451	8522	8593	8663	8734	8804	71
615	788875	8946	9016	9087	9157	9228	9299	9369	9440	9510	71
616	9581	9651	9722	9792	9863	9933	*0004	*0074	*0144	*0215	70
617	790285	0356	0426	0496	0567	0637	0707	0778	0848	0918	70
618	0988	1059	1129	1199	1269	1340	1410	1480	1550	1620	70
619	1691	1761	1831	1901	1971	2041	2111	2181	2252	2322	70
620	792392	2462	2532	2602	2672	2742	2812	2882	2952	3022	70
621	3092	3162	3231	3301	3371	3441	3511	3581	3651	3721	70
622	3790	3860	3930	4000	4070	4139	4209	4279	4349	4418	70
623	4488	4558	4627	4697	4767	4836	4906	4976	5045	5115	70
624	5185	5254	5324	5393	5463	5532	5602	5672	5741	5811	70
625	795880	5949	6019	6088	6158	6227	6297	6366	6436	6505	69
626	6574	6644	6713	6782	6852	6921	6990	7060	7129	7198	69
627	7268	7337	7406	7475	7545	7614	7683	7752	7821	7890	69
628	7960	8029	8098	8167	8236	8305	8374	8443	8513	8582	69
629	8651	8720	8789	8858	8927	8996	9065	9134	9203	9272	69
630	799341	9409	9478	9547	9616	9685	9754	9823	9892	9961	69
631	800029	0098	0167	0236	0305	0373	0442	0511	0580	0648	69
632	0717	0786	0854	0923	0992	1061	1129	1198	1266	1335	69
633	1404	1472	1541	1609	1678	1747	1815	1884	1952	2021	69
634	2089	2158	2226	2295	2363	2432	2500	2568	2637	2705	68
635	802774	2842	2910	2979	3047	3116	3184	3252	3321	3389	68
636	3457	3525	3594	3662	3730	3798	3867	3935	4003	4071	68
637	4139	4208	4276	4344	4412	4480	4548	4616	4685	4753	68
638	4821	4889	4957	5025	5093	5161	5229	5297	5365	5433	68
639	5501	5569	5637	5705	5773	5841	5908	5976	6044	6112	68
640	806180	6248	6316	6384	6451	6519	6587	6655	6723	6790	68
641	6858	6926	6994	7061	7129	7197	7264	7332	7400	7467	68
642	7535	7603	7670	7738	7806	7873	7941	8008	8076	8143	68
643	8211	8279	8346	8414	8481	8549	8616	8684	8751	8818	67
644	8886	8953	9021	9088	9156	9223	9290	9358	9425	9492	67
645	809560	9627	9694	9762	9829	9896	9964	*0031	*0098	*0165	67
646	810233	0300	0367	0434	0501	0569	0636	0703	0770	0837	67
647	0904	0971	1039	1106	1173	1240	1307	1374	1441	1508	67
648	1575	1642	1709	1776	1843	1910	1977	2044	2111	2178	67
649	2245	2312	2379	2445	2512	2579	2646	2713	2780	2847	67

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PRO. P'TS	73	7	15	22	29	37	44	51	58	66	73
	72	7	14	22	29	36	43	50	58	65	72
	71	7	14	21	28	36	43	50	57	64	71
	70	7	14	21	28	35	42	49	56	63	70
	69	7	14	21	28	35	41	48	55	62	69
	68	7	14	20	27	34	41	48	54	61	68
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

650	812913	2980	3047	3114	3181	3247	3314	3381	3448	3514	67
651	3581	3648	3714	3781	3848	3914	3981	4048	4114	4181	67
652	4248	4314	4381	4447	4514	4581	4647	4714	4780	4847	67
653	4913	4980	5046	5113	5179	5246	5312	5378	5445	5511	66
654	5578	5644	5711	5777	5843	5910	5976	6042	6109	6175	66
655	816241	6308	6374	6440	6506	6573	6639	6705	6771	6838	66
656	6904	6970	7036	7102	7169	7235	7301	7367	7433	7499	66
657	7565	7631	7698	7764	7830	7896	7962	8028	8094	8160	66
658	8226	8292	8358	8424	8490	8556	8622	8688	8754	8820	66
659	8885	8951	9017	9083	9149	9215	9281	9346	9412	9478	66
660	819544	9610	9676	9741	9807	9873	9939	*0004	*0070	*0136	66
661	820201	0267	0333	0399	0464	0530	0595	0661	0727	0792	66
662	0858	0924	0989	1055	1120	1186	1251	1317	1382	1448	66
663	1514	1579	1645	1710	1775	1841	1906	1972	2037	2103	65
664	2168	2233	2299	2364	2430	2495	2560	2626	2691	2756	65
665	822822	2887	2952	3018	3083	3148	3213	3279	3344	3409	65
666	3474	3539	3605	3670	3735	3800	3865	3930	3996	4061	65
667	4126	4191	4256	4321	4386	4451	4516	4581	4646	4711	65
668	4776	4841	4906	4971	5036	5101	5166	5231	5296	5361	65
669	5426	5491	5556	5621	5686	5751	5815	5880	5945	6010	65
670	826075	6140	6204	6269	6334	6399	6464	6528	6593	6658	65
671	6723	6787	6852	6917	6981	7046	7111	7175	7240	7305	65
672	7369	7434	7499	7563	7628	7692	7757	7821	7886	7951	65
673	8015	8080	8144	8209	8273	8338	8402	8467	8531	8595	64
674	8660	8724	8789	8853	8918	8982	9046	9111	9175	9239	64
675	829304	9368	9432	9497	9561	9625	9690	9754	9818	9882	64
676	9947	*0011	*0075	*0139	*0204	*0268	*0332	*0396	*0460	*0525	64
677	830589	0653	0717	0781	0845	0909	0973	1037	1102	1166	64
678	1230	1294	1358	1422	1486	1550	1614	1678	1742	1806	64
679	1870	1934	1998	2062	2126	2189	2253	2317	2381	2445	64
680	832509	2573	2637	2700	2764	2828	2892	2956	3020	3083	64
681	3147	3211	3275	3338	3402	3466	3530	3593	3657	3721	64
682	3784	3848	3912	3975	4039	4103	4166	4230	4294	4357	64
683	4421	4484	4548	4611	4675	4739	4802	4866	4929	4993	64
684	5056	5120	5183	5247	5310	5373	5437	5500	5564	5627	63
685	835691	5754	5817	5881	5944	6007	6071	6134	6197	6261	63
686	6324	6387	6451	6514	6577	6641	6704	6767	6830	6894	63
687	6957	7020	7083	7146	7210	7273	7336	7399	7462	7525	63
688	7588	7652	7715	7778	7841	7904	7967	8030	8093	8156	63
689	8219	8282	8345	8408	8471	8534	8597	8660	8723	8786	63
690	838849	8912	8975	9038	9101	9164	9227	9289	9352	9415	63
691	9478	9541	9604	9667	9729	9792	9855	9918	9981	*0043	63
692	840106	0169	0232	0294	0357	0420	0482	0545	0608	0671	63
693	0733	0796	0859	0921	0984	1046	1109	1172	1234	1297	63
694	1359	1422	1485	1547	1610	1672	1735	1797	1860	1922	63
695	841985	2047	2110	2172	2235	2297	2360	2422	2484	2547	62
696	2609	2672	2734	2796	2859	2921	2983	3046	3108	3170	62
697	3233	3295	3357	3420	3482	3544	3606	3669	3731	3793	62
698	3855	3918	3980	4042	4104	4166	4229	4291	4353	4415	62
699	4477	4539	4601	4664	4726	4788	4850	4912	4974	5036	62

5	6	7
34	40	47
33	40	46
33	39	46
32	38	45
32	38	44
31	37	43
5	6	7

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700	845098	5160	5222	5284	5346	5408	5470	5532	5594	5656	62
701	5718	5780	5842	5904	5966	6028	6090	6151	6213	6275	62
702	6337	6399	6461	6523	6585	6646	6708	6770	6832	6894	62
703	6955	7017	7079	7141	7202	7264	7326	7388	7449	7511	62
704	7573	7634	7696	7758	7819	7881	7943	8004	8066	8128	62
705	848189	8251	8312	8374	8435	8497	8559	8620	8682	8743	62
706	8805	8866	8928	8989	9051	9112	9174	9235	9297	9358	61
707	9419	9481	9542	9604	9665	9726	9788	9849	9911	9972	61
708	850033	0095	0156	0217	0279	0340	0401	0462	0524	0585	61
709	0646	0707	0769	0830	0891	0952	1014	1075	1136	1197	61
710	851258	1320	1381	1442	1503	1564	1625	1686	1747	1809	61
711	1870	1931	1992	2053	2114	2175	2236	2297	2358	2419	61
712	2480	2541	2602	2663	2724	2785	2846	2907	2968	3029	61
713	3090	3150	3211	3272	3333	3394	3455	3516	3577	3637	61
714	3698	3759	3820	3881	3941	4002	4063	4124	4185	4245	61
715	854306	4367	4428	4488	4549	4610	4670	4731	4792	4852	61
716	4913	4974	5034	5095	5156	5216	5277	5337	5398	5459	61
717	5519	5580	5640	5701	5761	5822	5882	5943	6003	6064	60
718	6124	6185	6245	6306	6366	6427	6487	6548	6608	6668	60
719	6729	6789	6850	6910	6970	7031	7091	7152	7212	7272	60
720	857332	7393	7453	7513	7574	7634	7694	7755	7815	7875	60
721	7935	7995	8056	8116	8176	8236	8297	8357	8417	8477	60
722	8537	8597	8657	8718	8778	8838	8898	8958	9018	9078	60
723	9138	9198	9258	9318	9379	9439	9499	9559	9619	9679	60
724	9739	9799	9859	9918	9978	*0038	*0098	*0158	*0218	*0278	60
725	860338	0398	0458	0518	0578	0637	0697	0757	0817	0877	60
726	0937	0996	1056	1116	1176	1236	1295	1355	1415	1475	60
727	1534	1594	1654	1714	1773	1833	1893	1952	2012	2072	60
728	2131	2191	2251	2310	2370	2430	2489	2549	2608	2668	60
729	2728	2787	2847	2906	2966	3025	3085	3144	3204	3263	60
730	863323	3382	3442	3501	3561	3620	3680	3739	3799	3858	59
731	3917	3977	4036	4096	4155	4214	4274	4333	4392	4452	59
732	4511	4570	4630	4689	4748	4808	4867	4926	4985	5045	59
733	5104	5163	5222	5282	5341	5400	5459	5519	5578	5637	59
734	5696	5755	5814	5874	5933	5992	6051	6110	6169	6228	59
735	866287	6346	6405	6465	6524	6583	6642	6701	6760	6819	59
736	6878	6937	6996	7055	7114	7173	7232	7291	7350	7409	59
737	7467	7526	7585	7644	7703	7762	7821	7880	7939	7998	59
738	8056	8115	8174	8233	8292	8350	8409	8468	8527	8586	59
739	8644	8703	8762	8821	8879	8938	8997	9056	9114	9173	59
740	869232	9290	9349	9408	9466	9525	9584	9642	9701	9760	59
741	9818	9877	9935	9994	*0053	*0111	*0170	*0228	*0287	*0345	59
742	870404	0462	0521	0579	0638	0696	0755	0813	0872	0930	58
743	0989	1047	1106	1164	1223	1281	1339	1398	1456	1515	58
744	1573	1631	1690	1748	1806	1865	1923	1981	2040	2098	58
745	872156	2215	2273	2331	2389	2448	2506	2564	2622	2681	58
746	2739	2797	2855	2913	2972	3030	3088	3146	3204	3262	58
747	3321	3379	3437	3495	3553	3611	3669	3727	3785	3844	58
748	3902	3960	4018	4076	4134	4192	4250	4308	4366	4424	58
749	4482	4540	4598	4656	4714	4772	4830	4888	4945	5003	58
N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.

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750	875061	5119	5177	5235	5293	5351	5409	5466	5524	5582	58
751	5640	5698	5756	5813	5871	5929	5987	6045	6102	6160	58
752	6218	6276	6333	6391	6449	6507	6564	6622	6680	6737	58
753	6795	6853	6910	6968	7026	7083	7141	7199	7256	7314	58
754	7371	7429	7487	7544	7602	7659	7717	7774	7832	7889	58
755	877947	8004	8062	8119	8177	8234	8292	8349	8407	8464	57
756	8522	8579	8637	8694	8752	8809	8866	8924	8981	9039	57
757	9096	9153	9211	9268	9325	9383	9440	9497	9555	9612	57
758	9669	9726	9784	9841	9898	9956	*0013	*0070	*0127	*0185	57
759	880242	0299	0356	0413	0471	0528	0585	0642	0699	0756	57
760	880814	0871	0928	0985	1042	1099	1156	1213	1271	1328	57
761	1385	1442	1499	1556	1613	1670	1727	1784	1841	1898	57
762	1955	2012	2069	2126	2183	2240	2297	2354	2411	2468	57
763	2525	2581	2638	2695	2752	2809	2866	2923	2980	3037	57
764	3093	3150	3207	3264	3321	3377	3434	3491	3548	3605	57
765	883661	3718	3775	3832	3888	3945	4002	4059	4115	4172	57
766	4229	4285	4342	4399	4455	4512	4569	4625	4682	4739	57
767	4795	4852	4909	4965	5022	5078	5135	5192	5248	5305	57
768	5361	5418	5474	5531	5587	5644	5700	5757	5813	5870	57
769	5926	5983	6039	6096	6152	6209	6265	6321	6378	6434	56
770	886491	6547	6604	6660	6716	6773	6829	6885	6942	6998	56
771	7054	7111	7167	7223	7280	7336	7392	7449	7505	7561	56
772	7617	7674	7730	7786	7842	7898	7955	8011	8067	8123	56
773	8179	8236	8292	8348	8404	8460	8516	8573	8629	8685	56
774	8741	8797	8853	8909	8965	9021	9077	9134	9190	9246	56
775	889302	9358	9414	9470	9526	9582	9638	9694	9750	9806	56
776	9862	9918	9974	*0030	*0086	*0141	*0197	*0253	*0309	*0365	56
777	890421	0477	0533	0589	0645	0700	0756	0812	0868	0924	56
778	0980	1035	1091	1147	1203	1259	1314	1370	1426	1482	56
779	1537	1593	1649	1705	1760	1816	1872	1928	1983	2039	56
780	892095	2150	2206	2262	2317	2373	2429	2484	2540	2595	56
781	2651	2707	2762	2818	2873	2929	2985	3040	3096	3151	56
782	3207	3262	3318	3373	3429	3484	3540	3595	3651	3706	56
783	3762	3817	3873	3928	3984	4039	4094	4150	4205	4261	55
784	4316	4371	4427	4482	4538	4593	4648	4704	4759	4814	55
785	894870	4925	4980	5036	5091	5146	5201	5257	5312	5367	55
786	5423	5478	5533	5588	5644	5699	5754	5809	5864	5920	55
787	5975	6030	6085	6140	6195	6251	6306	6361	6416	6471	55
788	6526	6581	6636	6692	6747	6802	6857	6912	6967	7022	55
789	7077	7132	7187	7242	7297	7352	7407	7462	7517	7572	55
790	897627	7682	7737	7792	7847	7902	7957	8012	8067	8122	55
791	8176	8231	8286	8341	8396	8451	8506	8561	8615	8670	55
792	8725	8780	8835	8890	8944	8999	9054	9109	9164	9218	55
793	9273	9328	9383	9437	9492	9547	9602	9656	9711	9766	55
794	9821	9875	9930	9985	*0039	*0094	*0149	*0203	*0258	*0312	55
795	900367	0422	0476	0531	0586	0640	0695	0749	0804	0859	55
796	0913	0968	1022	1077	1131	1186	1240	1295	1349	1404	55
797	1458	1513	1567	1622	1676	1731	1785	1840	1894	1948	54
798	2003	2057	2112	2166	2221	2275	2329	2384	2438	2492	54
799	2547	2601	2655	2710	2764	2818	2873	2927	2981	3036	54

N.	Dif.	1	2	3	4	5	6	7	8	9	Dif.
Pr. Pts.	57	6	11	17	23	29	34	40	46	51	57
	56	6	11	17	22	28	34	39	45	50	56
	55	6	11	17	22	28	33	39	44	50	55
	54	5	11	16	22	27	32	38	43	49	54
	Di										

N.	0	1	2	3	4	5	6	7	8	9	Diff.
800	903090	3144	3199	3253	3307	3361	3416	3470	3524	3578	54
801	3633	3687	3741	3795	3849	3904	3958	4012	4066	4120	54
802	4174	4229	4283	4337	4391	4445	4499	4553	4607	4661	54
803	4716	4770	4824	4878	4932	4986	5040	5094	5148	5202	54
804	5256	5310	5364	5418	5472	5526	5580	5634	5688	5742	54
805	905796	5850	5904	5958	6012	6066	6119	6173	6227	6281	54
806	6335	6389	6443	6497	6551	6604	6658	6712	6766	6820	54
807	6874	6927	6981	7035	7089	7143	7196	7250	7304	7358	54
808	7411	7465	7519	7573	7626	7680	7734	7787	7841	7895	54
809	7949	8002	8056	8110	8163	8217	8270	8324	8378	8431	54
810	908485	8539	8592	8646	8699	8753	8807	8860	8914	8967	54
811	9021	9074	9128	9181	9235	9289	9342	9396	9449	9503	54
812	9556	9610	9663	9716	9770	9823	9877	9930	9984	*0037	53
813	910091	0144	0197	0251	0304	0358	0411	0464	0518	0571	53
814	0624	0678	0731	0784	0838	0891	0944	0998	1051	1104	53
815	911158	1211	1264	1317	1371	1424	1477	1530	1584	1637	53
816	1690	1743	1797	1850	1903	1956	2009	2063	2116	2169	53
817	2222	2275	2328	2381	2435	2488	2541	2594	2647	2700	53
818	2753	2806	2859	2913	2966	3019	3072	3125	3178	3231	53
819	3284	3337	3390	3443	3496	3549	3602	3655	3708	3761	53
820	913814	3867	3920	3973	4026	4079	4132	4184	4237	4290	53
821	4343	4396	4449	4502	4555	4608	4660	4713	4766	4819	53
822	4872	4925	4977	5030	5083	5136	5189	5241	5294	5347	53
823	5400	5453	5505	5558	5611	5664	5716	5769	5822	5875	53
824	5927	5980	6033	6085	6138	6191	6243	6296	6349	6401	53
825	916454	6507	6559	6612	6664	6717	6770	6822	6875	6927	53
826	6980	7033	7085	7138	7190	7243	7295	7348	7400	7453	53
827	7506	7558	7611	7663	7716	7768	7820	7873	7925	7978	52
828	8030	8083	8135	8188	8240	8293	8345	8397	8450	8502	52
829	8555	8607	8659	8712	8764	8816	8869	8921	8973	9026	52
830	919078	9130	9183	9235	9287	9340	9392	9444	9496	9549	52
831	9601	9653	9706	9758	9810	9862	9914	9967	*0019	*0071	52
832	920123	0176	0228	0280	0332	0384	0436	0489	0541	0593	52
833	0645	0697	0749	0801	0853	0906	0958	1010	1062	1114	52
834	1166	1218	1270	1322	1374	1426	1478	1530	1582	1634	52
835	921686	1738	1790	1842	1894	1946	1998	2050	2102	2154	52
836	2206	2258	2310	2362	2414	2466	2518	2570	2622	2674	52
837	2725	2777	2829	2881	2933	2985	3037	3089	3140	3192	52
838	3244	3296	3348	3399	3451	3503	3555	3607	3658	3710	52
839	3762	3814	3865	3917	3969	4021	4072	4124	4176	4228	52
840	924279	4331	4383	4434	4486	4538	4589	4641	4693	4744	52
841	4796	4848	4899	4951	5003	5054	5106	5157	5209	5261	52
842	5312	5364	5415	5467	5518	5570	5621	5673	5725	5776	52
843	5828	5879	5931	5982	6034	6085	6137	6188	6240	6291	51
844	6342	6394	6445	6497	6548	6600	6651	6702	6754	6805	51
845	926857	6908	6959	7011	7062	7114	7165	7216	7268	7319	51
846	7370	7422	7473	7524	7576	7627	7678	7730	7781	7832	51
847	7883	7935	7986	8037	8088	8140	8191	8242	8293	8345	51
848	8396	8447	8498	8549	8601	8652	8703	8754	8805	8857	51
849	8908	8959	9010	9061	9112	9163	9215	9266	9317	9368	51

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PR. PTS.	55	6	11	17	22	28	33	39	44	50	55
	54	5	11	16	22	27	32	38	43	49	54
	53	5	11	16	21	27	32	37	42	48	53
	52	5	10	16	21	26	31	36	42	47	52
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

N.	0	1	2	3	4	5	6	7	8	9	Dif.
850	929419	9470	9521	9572	9623	9674	9725	9776	9827	9879	51
851	9930	9981	*0032	*0083	*0134	*0185	*0236	*0287	*0338	*0389	51
852	930440	0491	0542	0592	0643	0694	0745	0796	0847	0898	51
853	0949	1000	1051	1102	1153	1204	1254	1305	1356	1407	51
854	1458	1509	1560	1610	1661	1712	1763	1814	1865	1915	[illegible]
855	931966	2017	2068	2118	2169	2220	2271	2322	2372	2423	51
856	2474	2524	2575	2626	2677	2727	2778	2829	2879	2930	51
857	2981	3031	3082	3133	3183	3234	3285	3335	3386	3437	51
858	3487	3538	3589	3639	3690	3740	3791	3841	3892	3943	51
859	3993	4044	4094	4145	4195	4246	4296	4347	4397	4448	51
860	934498	4549	4599	4650	4700	4751	4801	4852	4902	4953	50
861	5003	5054	5104	5154	5205	5255	5306	5356	5406	5457	50
862	5507	5558	5608	5658	5709	5759	5809	5860	5910	5960	50
863	6011	6061	6111	6162	6212	6262	6313	6363	6413	6463	50
864	6514	6564	6614	6665	6715	6765	6815	6865	6916	6966	50
865	937016	7066	7117	7167	7217	7267	7317	7367	7418	7468	50
866	7518	7568	7618	7668	7718	7769	7819	7869	7919	7969	50
867	8019	8069	8119	8169	8219	8269	8320	8370	8420	8470	50
868	8520	8570	8620	8670	8720	8770	8820	8870	8920	8970	50
869	9020	9070	9120	9170	9220	9270	9320	9369	9419	9469	50
870	939519	9569	9619	9669	9719	9769	9819	9869	9918	9968	50
871	940018	0068	0118	0168	0218	0267	0317	0367	0417	0467	50
872	0516	0566	0616	0666	0716	0765	0815	0865	0915	0964	50
873	1014	1064	1114	1163	1213	1263	1313	1362	1412	1462	50
874	1511	1561	1611	1660	1710	1760	1809	1859	1909	1958	50
875	942008	2058	2107	2157	2207	2256	2306	2355	2405	2455	50
876	2504	2554	2603	2653	2702	2752	2801	2851	2901	2950	50
877	3000	3049	3099	3148	3198	3247	3297	3346	3396	[illegible]	49
878	3495	3544	3593	3643	3692	3742	3791	3841	3890	3939	49
879	3989	4038	4088	4137	4186	4236	4285	4335	4384	4433	[illegible]
880	944483	4532	4581	4631	4680	4729	4779	4828	4877	4927	49
881	4976	5025	5074	5124	5173	5222	5272	5321	5370	5419	49
882	5469	5518	5567	5616	5665	5715	5764	5813	5862	5912	[illegible]
883	5961	6010	6059	6108	6157	6207	6256	6305	6354	6403	49
884	6452	6501	6551	6600	6649	6698	6747	6796	6845	6894	49
885	946943	6992	7041	7090	7140	7189	7238	7287	7336	7385	49
886	7434	7483	7532	7581	7630	7679	7728	7777	7826	7875	49
887	7924	7973	8022	8070	8119	8168	8217	8266	8315	8364	49
888	8413	8462	8511	8560	8609	8657	8706	8755	8804	8853	49
889	8902	8951	8999	9048	9097	9146	9195	9244	9292	9341	49
890	949390	9439	9488	9536	9585	9634	9683	9731	9780	9829	49
891	9878	9926	9975	*0024	*0073	*0121	*0170	*0219	*0267	*0316	49
892	950365	0414	0462	0511	0560	0608	0657	0706	0754	0803	49
893	0851	0900	0949	0997	1046	1095	1143	1192	1240	1289	49
894	1338	1386	1435	1483	1532	1580	1629	1677	1726	1775	49
895	951823	1872	1920	1969	2017	2066	2114	2163	2211	2260	48
896	2308	2356	2405	2453	2502	2550	2599	2647	2696	2744	48
897	2792	2841	2889	2938	2986	3034	3083	3131	3180	3228	48
898	3276	3325	3373	3421	3470	3518	3566	3615	3663	3711	48
899	3760	3808	3856	3905	3953	4001	[illegible]	4098	4146	4194	48
N.	Dif.	1	2	3	4	5	6	7			

36
35
34
34

7

N	0	1	2	3	4	5	6	7	8	9	Dif.
900	954243	4291	4339	4387	4435	4484	4532	4580	4628	4677	48
901	4725	4773	4821	4869	4918	4966	5014	5062	5110	5158	48
902	5207	5255	5303	5351	5399	5447	5495	5543	5592	5640	48
903	5688	5736	5784	5832	5880	5928	5976	6024	6072	6120	48
904	6168	6216	6265	6313	6361	6409	6457	6505	6553	6601	48
905	956649	6697	6745	6793	6840	6888	6936	6984	7032	7080	48
906	7128	7176	7224	7272	7320	7368	7416	7464	7512	7559	48
907	7607	7655	7703	7751	7799	7847	7894	7942	7990	8038	48
908	8086	8134	8181	8229	8277	8325	8373	8421	8468	8516	48
909	8564	8612	8659	8707	8755	8803	8850	8898	8946	8994	48
910	959041	9089	9137	9185	9232	9280	9328	9375	9423	9471	48
911	9518	9566	9614	9661	9709	9757	9804	9852	9900	9947	48
912	9995	*0042	*0090	*0138	*0185	*0233	*0280	*0328	*0376	*0423	48
913	960471	0518	0566	0613	0661	0709	0756	0804	0851	0899	48
914	0946	0994	1041	1089	1136	1184	1231	1279	1326	1374	48
915	961421	1469	1516	1563	1611	1658	1706	1753	1801	1848	47
916	1895	1943	1990	2038	2085	2132	2180	2227	2275	2322	47
917	2369	2417	2464	2511	2559	2606	2653	2701	2748	2795	47
918	2843	2890	2937	2985	3032	3079	3126	3174	3221	3268	47
919	3316	3363	3410	3457	3504	3552	3599	3646	3693	3741	47
920	963788	3835	3882	3929	3977	4024	4071	4118	4165	4212	47
921	4260	4307	4354	4401	4448	4495	4542	4590	4637	4684	47
922	4731	4778	4825	4872	4919	4966	5013	5061	5108	5155	47
923	5202	5249	5296	5343	5390	5437	5484	5531	5578	5625	47
924	5672	5719	5766	5813	5860	5907	5954	6001	6048	6095	47
925	966142	6189	6236	6283	6329	6376	6423	6470	6517	6564	47
926	6611	6658	6705	6752	6799	6845	6892	6939	6986	7033	47
927	7080	7127	7173	7220	7267	7314	7361	7408	7454	7501	47
928	7548	7595	7642	7688	7735	7782	7829	7875	7922	7969	47
929	8016	8062	8109	8156	8203	8249	8296	8343	8390	8436	47
930	968483	8530	8576	8623	8670	8716	8763	8810	8856	8903	47
931	8950	8996	9043	9090	9136	9183	9229	9276	9323	9369	47
932	9416	9463	9509	9556	9602	9649	9695	9742	9789	9835	47
933	9882	9928	9975	*0021	*0068	*0114	*0161	*0207	*0254	*0300	47
934	970347	0393	0440	0486	0533	0579	0626	0672	0719	0765	46
935	970812	0858	0904	0951	0997	1044	1090	1137	1183	1229	46
936	1276	1322	1369	1415	1461	1508	1554	1601	1647	1693	46
937	1740	1786	1832	1879	1925	1971	2018	2064	2110	2157	46
938	2203	2249	2295	2342	2388	2434	2481	2527	2573	2619	46
939	2666	2712	2758	2804	2851	2897	2943	2989	3035	3082	46
940	973128	3174	3220	3266	3313	3359	3405	3451	3497	3543	46
941	3590	3636	3682	3728	3774	3820	3866	3913	3959	4005	46
942	4051	4097	4143	4189	4235	4281	4327	4374	4420	4466	46
943	4512	4558	4604	4650	4696	4742	4788	4834	4880	4926	46
944	4972	5018	5064	5110	5156	5202	5248	5294	5340	5386	46
945	975432	5478	5524	5570	5616	5662	5707	5753	5799	5845	46
946	5891	5937	5983	6029	6075	6121	6167	6212	6258	6304	46
947	6350	6396	6442	6488	6533	6579	6625	6671	6717	6763	46
948	6808	6854	6900	6946	6992	7037	7083	7129	7175	7220	46
949	7266	7312	7358	7403	7449	7495	7541	7586	7632	7678	46
N.	Dif.	1	2	3	4	5	6	7	8	9	Dif.

4	48
3	48
2	47
1	46
	Dif.

TABLE XII.—LOGARITHMS OF NUMBERS.

N.	0	1	2	3	4	5	6	7	8	9	Dif.
950	977724	7769	7815	7861	7906	7952	7998	8043	8089	8135	46
951	8181	8226	8272	8317	8363	8409	8454	8500	8546	8591	46
952	8637	8683	8728	8774	8819	8865	8911	8956	9002	9047	46
953	9093	9138	9184	9230	9275	9321	9366	9412	9457	9503	46
954	9548	9594	9639	9685	9730	9776	9821	9867	9912	9958	46
955	980003	0049	0094	0140	0185	0231	0276	0322	0367	0412	45
956	0458	0503	0549	0594	0640	0685	0730	0776	0821	0867	45
957	0912	0957	1003	1048	1093	1139	1184	1229	1275	1320	45
958	1366	1411	1456	1501	1547	1592	1637	1683	1728	1773	45
959	1819	1864	1909	1954	2000	2045	2090	2135	2181	2226	45
960	982271	2316	2362	2407	2452	2497	2543	2588	2633	2678	45
961	2723	2769	2814	2859	2904	2949	2994	3040	3085	3130	45
962	3175	3220	3265	3310	3356	3401	3446	3491	3536	3581	45
963	3626	3671	3716	3762	3807	3852	3897	3942	3987	4032	45
964	4077	4122	4167	4212	4257	4302	4347	4392	4437	4482	45
965	984527	4572	4617	4662	4707	4752	4797	4842	4887	4932	45
966	4977	5022	5067	5112	5157	5202	5247	5292	5337	5382	45
967	5426	5471	5516	5561	5606	5651	5696	5741	5786	5830	45
968	5875	5920	5965	6010	6055	6100	6144	6189	6234	6279	45
969	6324	6369	6413	6458	6503	6548	6593	6637	6682	6727	45
970	986772	6817	6861	6906	6951	6996	7040	7085	7130	7175	45
971	7219	7264	7309	7353	7398	7443	7488	7532	7577	7622	45
972	7666	7711	7756	7800	7845	7890	7934	7979	8024	8068	45
973	8113	8157	8202	8247	8291	8336	8381	8425	8470	8514	45
974	8559	8604	8648	8693	8737	8782	8826	8871	8916	8960	45
975	989005	9049	9094	9138	9183	9227	9272	9316	9361	9405	45
976	9450	9494	9539	9583	9628	9672	9717	9761	9806	9850	44
977	9895	9939	9983	*0028	*0072	*0117	*0161	*0206	*0250	*0294	44
978	990339	0383	0428	0472	0516	0561	0605	0650	0694	0738	44
979	0783	0827	0871	0916	0960	1004	1049	1093	1137	1182	44
980	991226	1270	1315	1359	1403	1448	1492	1536	1580	1625	44
981	1669	1713	1758	1802	1846	1890	1935	1979	2023	2067	44
982	2111	2156	2200	2244	2288	2333	2377	2421	2465	2509	44
983	2554	2598	2642	2686	2730	2774	2819	2863	2907	2951	44
984	2995	3039	3083	3127	3172	3216	3260	3304	3348	3392	44
985	993436	3480	3524	3568	3613	3657	3701	3745	3789	3833	44
986	3877	3921	3965	[illegible]	4053	4097	4141	4185	4229	4273	44
987	4317	4361	4405	4449	4493	4537	4581	4625	4669	4713	44
988	4757	4801	4845	4889	4933	4977	5021	5065	5108	5152	44
989	5196	5240	5284	5328	5372	5416	5460	5504	5547	5591	44
990	995635	5679	5723	5767	5811	5854	5898	5942	5986	6030	44
991	6074	6117	6161	6205	6249	6293	6337	6380	6424	6468	44
992	6512	6555	6599	6643	6687	6731	6774	6818	6862	6906	44
993	6949	6993	7037	7080	7124	7168	7212	7255	7299	7343	44
994	7386	7430	7474	7517	7561	7605	7648	7692	7736	7779	44
995	997823	7867	7910	7954	7998	8041	8085	8129	8172	8216	44
996	8259	8303	8347	8390	8434	8477	8521	8564	8608	8652	44
997	8695	8739	8782	8826	8869	8913	8956	9000	9043	9087	44
998	9131	9174	9218	9261	9305	9348	9392	9435	9479	9522	44
999	9565	9609	9652	9696	9739	9783	9826	9870	9913	9957	43

N.	Dif.	1	2	3	4	5	6	7	8	9	Dif.
PR. PTS.	46	5	9	14	18	23	28	32	37	41	[illegible]
	45	5	9	14	18	23	27	32	36	41	45
	44	4	9	13	18	22	26	31	35	40	44
	43	4	9	13	17	22	[illegible]	30	34	39	43

N.	0	1	2	3	4	5	6	7	8	9	Diff.
1000	000000	0043	0087	0130	0174	0217	0260	0304	0347	0391	43
1001	0434	0477	0521	0564	0608	0651	0694	0738	0781	0824	43
1002	0868	0911	0954	0998	1041	1084	1128	1171	1214	1258	43
1003	1301	1344	1388	1431	1474	1517	1561	1604	1647	1690	43
1004	1734	1777	1820	1863	1907	1950	1993	2036	2080	2123	43
1005	002166	2209	2252	2296	2339	2382	2425	2468	2512	2555	43
1006	2598	2641	2684	2727	2771	2814	2857	2900	2943	2986	43
1007	3029	3073	3116	3159	3202	3245	3288	3331	3374	3417	43
1008	3461	3504	3547	3590	3633	3676	3719	3762	3805	3848	43
1009	3891	3934	3977	4020	4063	4106	4149	4192	4235	4278	43
1010	004321	4364	4407	4450	4493	4536	4579	4622	4665	4708	43
1011	4751	4794	4837	4880	4923	4966	5009	5052	5095	5138	43
1012	5181	5223	5266	5309	5352	5395	5438	5481	5524	5567	43
1013	5609	5652	5695	5738	5781	5824	5867	5909	5952	5995	43
1014	6038	6081	6124	6166	6209	6252	6295	6338	6380	6423	43
1015	006466	6509	6552	6594	6637	6680	6723	6765	6808	6851	43
1016	6894	6936	6979	7022	7065	7107	7150	7193	7236	7278	43
1017	7321	7364	7406	7449	7492	7534	7577	7620	7662	7705	43
1018	7748	7790	7833	7876	7918	7961	8004	8046	8089	8132	43
1019	8174	8217	8259	8302	8345	8387	8430	8472	8515	8558	43
1020	008600	8643	8685	8728	8770	8813	8856	8898	8941	8983	43
1021	9026	9068	9111	9153	9196	9238	9281	9323	9366	9408	42
1022	9451	9493	9536	9578	9621	9663	9706	9748	9791	9833	42
1023	9876	9918	9961	*0003	*0045	*0088	*0130	*0173	*0215	*0258	42
1024	010300	0342	0385	0427	0470	0512	0554	0597	0639	0681	42
1025	010724	0766	0809	0851	0893	0936	0978	1020	1063	1105	42
1026	1147	1190	1232	1274	1317	1359	1401	1444	1486	1528	42
1027	1570	1613	1655	1697	1740	1782	1824	1866	1909	1951	42
1028	1993	2035	2078	2120	2162	2204	2247	2289	2331	2373	42
1029	2415	2458	2500	2542	2584	2626	2669	2711	2753	2795	42
1030	012837	2879	2922	2964	3006	3048	3090	3132	3174	3217	42
1031	3259	3301	3343	3385	3427	3469	3511	3553	3596	3638	42
1032	3680	3722	3764	3806	3848	3890	3932	3974	4016	4058	42
1033	4100	4142	4184	4226	4268	4310	4353	4395	4437	4479	42
1034	4521	4563	4605	4647	4689	4730	4772	4814	4856	4898	42
1035	014940	4982	5024	5066	5108	5150	5192	5234	5276	5318	42
1036	5360	5402	5444	5485	5527	5569	5611	5653	5695	5737	42
1037	5779	5821	5863	5904	5946	5988	6030	6072	6114	6156	42
1038	6197	6239	6281	6323	6365	6407	6448	6490	6532	6574	42
1039	6616	6657	6699	6741	6783	6824	6866	6908	6950	6992	42
1040	017033	7075	7117	7159	7200	7242	7284	7326	7367	7409	42
1041	7451	7492	7534	7576	7618	7659	7701	7743	7784	7826	42
1042	7868	7909	7951	7993	8034	8076	8118	8159	8201	8243	42
1043	8284	8326	8368	8409	8451	8492	8534	8576	8617	8659	42
1044	8700	8742	8784	8825	8867	8908	8950	8992	9033	9075	42
1045	019116	9158	9199	9241	9282	9324	9366	9407	9449	9490	42
1046	9532	9573	9615	9656	9698	9739	9781	9822	9864	9905	41
1047	9947	9988	*0030	*0071	*0113	*0154	*0195	*0237	*0278	*0320	41
1048	020361	0403	0444	0486	0527	0568	0610	0651	0693	0734	41
1049	0775	0817	0858	0900	0941	0982	1024	1065	1107	1148	41
1050	021189	1231	1272	1313	1355	1396	1437	1479	1520	1561	41

N.	Diff.	1	2	3	4	5	6	7	8	9	Diff.
PR. PTS.	44	4	9	13	18	22	26	31	35	40	44
	43	4	9	13	17	22	26	30	34	39	43
	42	4	8	13	17	21	25	29	34	38	42
	41	4	8	12	16	21	25	29	33	37	41
	Diff.	1	2	3	4	5	6	7	8	9	Diff.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	— ∞		10.000000		— ∞		— ∞	60
1	6.[illegible]26	5017.17	.000000	.00	6.[illegible]26	5017.17	3.536274	59
2	[illegible]56	2934.85	.000000	.00	[illegible]56	2934.85	.235244	58
3	[illegible]47	2082.32	.000000	.00	[illegible]47	2082.32	.059153	57
4	7.[illegible]86	1615.17	.000000	.00	7.[illegible]86	1615.17	2.934214	56
5	7[illegible]96	1319.68	10.000000	.02	7.[illegible]96	1319.70	2.837304	55
6	[illegible]77	1115.78	9.999999	.00	[illegible]78	1115.78	.758122	54
7	[illegible]24	966.53	.999999	.00	[illegible]25	966.53	.691175	53
8	[illegible]16	852.53	.999999	.00	[illegible]17	852.55	.633183	52
9	[illegible]68	762.63	.999999	.02	[illegible]70	762.62	.582030	51
10	[illegible]26	689.87	[illegible]98	.00	7.463727	689.88	2.536273	50
11	[illegible]18	629.80	[illegible]98	.02	.505120	629.82	.494880	49
12	[illegible]06	579.37	[illegible]97	.00	.542909	579.38	.457091	48
13	[illegible]68	536.42	[illegible]97	.02	.577672	536.42	.422328	47
14	[illegible]53	499.38	[illegible]96	.00	.609857	499.38	.390143	46
15	[illegible]16	467.15	[illegible]96	.02	7.639820	467.15	2.360180	45
16	[illegible]45	438.80	[illegible]95	.00	.667849	438.83	.332151	44
17	[illegible]73	413.73	[illegible]95	.02	.694179	413.73	.305821	43
18	[illegible]97	391.35	[illegible]94	.02	.719003	391.35	.280997	42
19	[illegible]78	371.27	.999993	.00	.742484	371.28	.257516	41
20	7.[illegible]54	353.15	9.999993	.02	7[illegible]61	353.17	2.235239	40
21	[illegible]43	336.72	.999992	.02	[illegible]51	336.73	.214049	39
22	[illegible]46	321.75	.999991	.02	[illegible]55	321.75	.193845	38
23	[illegible]51	308.05	.999990	.02	[illegible]60	308.07	.174540	37
24	[illegible]34	295.47	.999989	.00	[illegible]44	295.50	.156056	36
25	7.[illegible]62	283.88	9.999989	.02	7.[illegible]74	283.90	2.138326	35
26	[illegible]95	273.17	.999988	.02	[illegible]08	273.18	.121292	34
27	[illegible]85	263.23	.999987	.02	[illegible]99	263.25	.104901	33
28	[illegible]79	254.00	.999986	.02	[illegible]94	254.00	.089106	32
29	[illegible]19	245.38	.999985	.03	[illegible]34	245.40	.073866	31
30	7.940842	237.33	9.999983	.02	7.940858	237.37	2.059142	30
31	.955082	229.80	.999982	.02	.955100	229.82	.044900	29
32	.968870	222.72	.999981	.02	.968889	222.73	.031111	28
33	.982233	216.08	.999980	.02	.982253	216.10	.017747	27
34	.995198	209.82	.999979	.03	.995219	209.83	.004781	26
35	8.007787	203.90	9.999977	.02	8.007809	203.92	1.992191	25
36	.020021	198.30	.999976	.02	.020044	198.35	.979956	24
37	.031919	193.03	.999975	.03	.031945	193.03	.968055	23
38	.043501	188.00	.999973	.02	.043527	188.03	.956473	22
39	.054781	183.25	.999972	.02	.054809	183.28	.945191	21
40	8.[illegible]76	178.73	[illegible]71	.03	8.065806	178.75	1.934194	20
41	[illegible]00	174.42	[illegible]69	.02	.076531	174.43	.923469	19
42	[illegible]65	170.30	[illegible]68	.03	.086997	170.33	.913003	18
43	[illegible]83	166.40	[illegible]66	.03	.097217	166.43	.902783	17
44	[illegible]67	162.65	[illegible]64	.02	.107203	162.67	.892797	16
45	8.[illegible]06	159.08	9.999963	.03	8.116963	159.12	1.883037	15
46	[illegible]71	155.65	.999961	.03	.126510	155.68	.873490	14
47	[illegible]10	152.38	.999959	.02	.135851	152.42	.864149	13
48	[illegible]53	149.23	.999958	.03	.144996	149.27	.855004	12
49	153907	146.23	.999956	.03	.153952	146.25	.846048	11
50	8.162681	143.32	9.999954	.03	8.162727	143.35	1.837273	10
51	.171280	140.55	.999952	.03	.171328	140.58	.828672	9
52	.179713	137.87	.999950	.03	.179763	137.88	.820237	8
53	.187985	135.28	.999948	.03	.188036	135.33	.811964	7
54	.196102	132.80	.999946	.03	.196156	132.63	.803844	6
55	8.204070	130.42	9.999944	.03	8.204126	130.45	1.795874	5
56	.211895	128.10	.999942	.03	.211953	128.13	.788047	4
57	.219581	125.88	.999940	.03	.219641	125.90	.780359	3
58	.227134	123.72	.999938	.03	.227195	123.77	.772805	2
59	.234557	121.63	.999936	.03	.234621	121.67	.765379	1
60	8.241855		9.999934		8.241921		1.758079	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M

∠ 180° - ∠

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	8.241855	119.63	9.999934	.03	8.241921	119.68	1.758079	60
1	.249033	117.68	.999932	.05	.249102	117.72	.750898	59
2	.256094	115.80	.999929	.03	.256165	115.83	.743835	58
3	.263042	113.98	.999927	.03	.263115	114.02	.736885	57
4	.269881	112.22	.999925	.05	.269956	112.25	.730044	56
5	8.276614	110.48	9.999922	.03	8.276691	110.53	1.723309	55
6	.283243	108.83	.999920	.03	.283323	108.88	.716677	54
7	.289773	107.23	.999918	.05	.289856	107.27	.710144	53
8	.296207	105.65	.999915	.03	.296292	105.70	.703708	52
9	.302546	104.13	.999913	.05	.302634	104.17	.697366	51
10	8.308794	102.67	9.999910	.05	8.308884	102.70	1.691116	50
11	.314954	101.22	.999907	.03	.315046	101.27	.684954	49
12	.321027	99.82	.999905	.05	.321122	99.87	.678878	48
13	.327016	98.47	.999902	.05	.327114	98.52	.672886	47
14	.332924	97.15	.999899	.03	.333025	97.18	.666975	46
15	8.338753	95.85	9.999897	.05	8.338856	95.90	1.661144	45
16	.344504	94.62	.999894	.05	.344610	94.65	.655390	44
17	.350181	93.37	.999891	.05	.350289	93.43	.649711	43
18	.355783	92.20	.999888	.05	.355895	92.25	.644105	[illegible]
19	.361315	91.03	.999885	.05	.361430	91.08	.638570	41
20	8.366777	89.90	9 82	.05	8.366895	89.95	1.633105	40
21	.372171	88.80	79	.05	.372292	88.83	.627708	39
22	.377499	87.72	76	.05	.377622	87.78	.622378	38
23	.382762	86.67	73	.05	.382889	86.72	.617111	37
24	.387962	85.65	70	.05	.388092	85.70	.611908	36
25	8.393101	84.63	9 67	.05	8.393234	84.68	1.606766	35
26	.398179	83.67	64	.05	.398315	83.72	.601685	34
27	.403199	82.70	61	.05	.403338	82.77	.596662	33
28	.408161	81.78	58	.07	.408304	81.82	.591696	32
29	.413068	80.85	54	.05	.413213	80.92	.586787	31
30	8.417919	79.97	51	.05	8.418068	80.02	1.581932	30
31	.422717	79.08	48	.07	.422869	79.15	.577131	29
32	.427462	78.23	44	.05	.427618	78.28	.572382	28
33	.432156	77.40	41	.05	.432315	77.45	.567685	27
34	.436800	76.57	38	.07	.436962	76.63	.563038	26
35	8.441394	75.78	34	.05	8.441560	75.83	1.558440	25
36	.445941	74.98	31	.07	.446110	75.05	.553890	24
37	.450440	74.22	27	.05	.450613	74.28	.549387	23
38	.454893	73.47	24	.07	.455070	73.52	.544930	22
39	.459301	72.73	20	.07	.459481	72.80	.540519	21
40	8. 65	72.00	9.999816	.05	8.463849	72.05	1.536151	20
41	. 85	71.30	.999813	.07	.468172	71.37	.531828	19
42	. 63	70.58	.999809	.07	.472454	70.65	.527546	18
43	. 98	69.92	.999805	.07	.476693	69.98	.523307	17
44	. 93	69.25	.999801	.07	.480892	69.30	.519108	16
45	8. 48	68.58	9.999797	.05	8.485050	68.67	1.514950	15
46	. 63	67.95	.999794	.07	.489170	68.00	.510830	14
47	. 40	67.30	.999790	.07	.493250	67.38	.506750	13
48	. 78	66.70	.999786	.07	.497293	66.75	.502707	12
49	. 80	66.08	.999782	.07	.501298	66.15	.498702	11
50	8.505045	65.48	9.999778	.07	8.505267	65.55	1.494733	10
51	.508974	64.88	999774	.08	.509200	64.97	.490800	9
52	.512867	64.32	.999769	.07	.513098	64.38	.486902	8
53	.516726	63.75	.999765	.07	.516961	63.82	.483039	7
54	.520551	63.20	.999761	.07	.520790	63.27	.479210	6
55	8.524343	62.65	9.999757	.07	8.524586	62.72	1.475414	5
56	.528102	62.10	.999753	.08	528349	62.18	.471651	4
57	.531828	61.58	.999748	.07	.532080	61.65	.467920	3
58	.535523	61.05	.999744	.07	.535779	61.13	.464221	2
59	.539186	60.55	.999740	.08	.539447	60.62	.460553	1
60	8.542819		9.999735		8.543084		1.456916	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

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M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	8.542819	60.05	9.999735	.07	8.543084	60.12	1.456916	60
1	.546422	59.55	.999731	.08	.546691	59.62	.453309	59
2	.549995	59.07	.999726	.07	.550268	59.15	.449732	58
3	.553539	58.58	.999722	.08	.553817	58.65	.446183	57
4	.557054	58.10	999717	.07	.557336	58.20	.442664	56
5	8.560540	57.65	9.999713	.08	8.560828	57.72	1.439172	55
6	.563999	57.20	.999708	.07	.564291	57.27	.435709	54
7	.567431	56.75	.999704	.08	.567727	56.83	.432273	53
8	.570836	56.30	999699	.08	.571137	56.38	.428863	52
9	.574214	55.87	.999694	.08	.574520	55.96	.425480	51
10	8.577566	55.43	9. 89	.07	8.577877	55.52	1.422123	50
11	.580892	55.02	. 85	.08	.581208	55.10	.418792	[illegible]
12	.584193	54.60	. 80	.08	.584514	54.68	.415486	[illegible]
13	.587469	54.20	. 75	.08	.587795	54.27	.412205	47
14	.590721	53.78	. 70	.08	.591051	53.87	.408949	46
15	8.593948	53.40	9. 65	.08	8.594283	53.48	1.405717	45
16	.597152	53.00	. 60	.08	.597492	53.08	.402508	44
17	.600332	52.62	. 55	.08	.600677	52.70	.399323	43
18	.603489	52.23	. 50	.08	.603839	52.32	.396161	42
19	.606623	51.85	. 45	.08	.606978	51.93	.393022	41
20	8. 34	51.48	9.999640	.08	8.610094	51.58	1.389906	40
21	. 23	51.13	.999635	.10	.613189	51.22	.386811	39
22	. 91	50.77	.999629	.08	.616262	50.85	.383738	38
23	. 37	50.42	.999624	.08	.619313	50.50	.380687	37
24	. 62	50.05	.999619	.08	.622343	50.15	.377657	36
25	8. 65	49.72	9.999614	.10	8.625352	49.80	1.374648	35
26	. 48	49.38	.999608	.08	.628340	49.47	.371660	34
27	. 11	49.05	.999603	.10	.631308	49.13	.368692	33
28	. 54	48.70	.999597	.08	.634256	48.80	.365744	32
29	. 76	48.40	.999592	.10	.637184	48.48	.362816	31
30	8. 80	48.05	9.999586	.08	8.640093	48.15	1.359907	30
31	. 63	47.75	.999581	.10	.642982	47.85	.357018	29
32	. 28	47.43	.999575	.08	.645853	47.52	.354147	28
33	. 74	47.13	.999570	.10	.648704	47.22	.351296	27
34	. 02	46.82	.999564	.10	.651537	46.92	.348463	26
35	8. 11	46.52	9.999558	.08	8.654352	46.62	1.345648	25
36	. 02	46.22	.999553	.10	.657149	46.32	.342851	24
37	. 75	45.92	.999547	.10	.659928	46.02	.340072	23
38	. 30	45.63	.999541	.10	.662689	45.73	.337311	22
39	. 68	45.35	.999535	.10	.665433	45.45	.334567	21
40	8.667689	45.07	9.999529	.08	8.668160	45.17	1.331840	20
41	.670393	44.78	.999524	.10	.670870	44.88	.329130	19
42	.673080	44.52	.999518	.10	.673563	44.60	.326437	18
43	.675751	44.23	.999512	.10	.676239	44.35	.323761	17
44	.678405	43.97	.999506	.10	.678900	44.07	.321100	16
45	8.681043	43.70	9.999500	.12	8.681544	43.80	1.318456	15
46	.683665	43.45	.999493	.10	.684172	43.53	.315828	14
47	.686272	43.18	.999487	.10	.686784	43.28	.313216	13
48	.688863	42.92	.999481	.10	.689381	43.03	.310619	12
49	.691438	42.67	.999475	.10	.691963	42.77	.308037	11
50	8.693998	42.42	9.999469	.10	8.694529	42.53	1.305471	10
51	.696543	42.17	.999463	.12	.697081	42.27	.302919	9
52	699073	41.93	.999456	.10	.699617	42.03	.300383	8
53	.701589	41.68	.999450	.12	.702139	41.78	.297861	7
54	704090	41.45	.999443	.10	.704646	41.57	.295354	6
55	8.706577	41.20	9.999437	.10	8.707140	41.30	1.292860	5
56	.709049	40.97	.999431	.12	.709618	41.08	.290382	4
57	.711507	40.75	.999424	.10	.712083	40.85	.287917	3
58	713952	40.52	.999418	.12	.714534	40.63	.285466	2
59	.716383	40.28	.999411	.12	.716972	40.40	.283028	1
60	8.718800		9.999404		8.719396		1.280604	0
	Cos.	D. 1″.	Sin.	D 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	8.718800	40.07	9.999404	.10	8.719396	40.17	1.280604	60
1	.721204	39.85	.999398	.12	.721806	39.97	.278194	59
2	.723595	39.62	.999391	.12	.724204	39.73	.275796	58
3	.725972	39.42	.999384	.10	.726588	39.52	.273412	57
4	.728337	39.18	.999378	.12	.728959	39.30	.271041	56
5	8.730688	38.98	9.999371	.12	8.731317	39.10	1.268683	55
6	.733027	38.78	.999364	.12	.733663	38.88	.266337	54
7	.735354	38.55	.999357	.12	.735996	38.68	.264004	53
8	.737667	38.37	.999350	.12	.738317	38.48	.261683	52
9	.739969	38.17	.999343	.12	.740626	38.27	.259374	51
10	8.742259	37.95	9.999336	.12	8.742922	38.08	1.257078	50
11	.744536	37.77	.999329	.12	.745207	37.87	.254793	49
12	.746802	37.55	.999322	.12	.747479	37.68	.252521	48
13	.749055	37.37	.999315	.12	.749740	37.48	.250260	47
14	.751297	37.18	.999308	.12	.751989	37.30	.248011	46
15	8.753528	36.98	9.999301	.12	8.754227	37.10	1.245773	45
16	.755747	36.80	.999294	.12	.756453	36.92	.243547	44
17	.757955	36.60	.999287	.13	.758668	36.73	.241332	43
18	.760151	36.43	.999279	.12	.760872	36.55	.239128	42
19	.762337	36.23	.999272	.12	.763065	36.35	.236935	41
20	8.764511	36.07	9.999265	.13	8.765246	36.18	1.234754	40
21	.766675	35.88	.999257	.12	.767417	36.02	.232583	39
22	.768828	35.70	.999250	.13	.769578	35.82	.230422	38
23	.770970	35.53	.999242	.12	.771727	35.65	.228273	37
24	.773101	35.37	.999235	.13	.773866	35.48	.226134	36
25	8.775223	35.17	9.999227	.12	8.775995	35.32	1.224005	35
26	.777333	35.02	.999220	.13	.778114	35.13	.221886	34
27	.779434	34.83	.999212	.12	.780222	34.97	.219778	33
28	.781524	34.68	.999205	.13	.782320	34.80	.217680	32
29	.783605	34.50	.999197	.13	.784408	34.63	.215592	31
30	8.[illegible]75	34.35	9.999189	.13	8.[illegible]86	34.47	1.213514	30
31	.[illegible]36	34.18	.999181	.12	.[illegible]54	34.32	.211446	29
32	.[illegible]87	34.02	.999174	.13	.[illegible]13	34.15	.209387	28
33	.[illegible]28	33.85	.999166	.13	.[illegible]62	33.98	.207338	27
34	.[illegible]59	33.70	.999158	.13	.[illegible]01	33.83	.205299	26
35	8.[illegible]81	33.55	9.999150	.13	8.[illegible]31	33.68	1.203269	25
36	.[illegible]94	33.38	.999142	.13	.[illegible]52	33.52	.201248	24
37	.[illegible]97	33.25	.999134	.13	.[illegible]63	33.37	.199237	23
38	.[illegible]92	33.07	.999126	.13	.[illegible]65	33.22	.197235	22
39	.[illegible]76	32.93	.999118	.13	.[illegible]58	33.07	.195242	21
40	8.[illegible]52	32.78	9.999110	.13	8.[illegible]42	32.92	1.193258	20
41	.[illegible]19	32.63	.999102	.13	.[illegible]17	32.77	.191283	19
42	.[illegible]77	32.48	.999094	.13	.[illegible]83	32.63	.189317	18
43	.[illegible]26	32.35	.999086	.15	.[illegible]41	32.47	.187359	17
44	.[illegible]67	32.20	.999077	.13	.[illegible]89	32.33	.185411	16
45	8.[illegible]99	32.05	9.999069	.13	8.[illegible]29	32.20	1.183471	15
46	.[illegible]22	31.90	.999061	.13	.[illegible]61	32.05	.181539	14
47	.[illegible]36	31.78	.999053	.15	.[illegible]84	31.90	.179616	13
48	.[illegible]43	31.62	.999044	.13	.[illegible]98	31.78	.177702	12
49	.[illegible]40	31.50	.999036	.15	.[illegible]05	31.63	.175795	11
50	8[illegible]30	31.35	9.999027	.13	8.826103	31.48	1.173897	10
51	[illegible]41	31.22	.999019	.15	.827992	31.37	.172008	9
52	[illegible]84	31.08	.999010	.13	.829874	31.23	.170126	8
53	[illegible]49	30.97	.999002	.15	.831748	31.08	.168252	7
54	[illegible]07	30.82	.998993	.15	.833613	30.97	.166387	6
55	8[illegible]56	30.68	9.998984	.13	8.835471	30.83	1.164529	5
56	[illegible]97	30.55	.998976	.15	.837321	30.70	.162679	4
57	[illegible]30	30.43	.998967	.15	.839163	30.58	.160837	3
58	[illegible]56	30.30	.998958	.13	.840998	30.45	.159002	2
59	[illegible]74	30.18	.998950	.15	.842825	30.32	.157175	1
60	8[illegible]85		9.998941		8.844644		1.155356	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	1 85	30.03	41	.15	8.844644	30.18	1.155356	60
1	87	29.93	32	.15	.846455	30.08	.153545	59
2	83	29.80	23	.15	.848260	29.95	.151740	58
3	71	29.67	14	.15	.850057	29.82	.149943	57
4	51	29.57	05	.15	.851846	29.70	.148154	56
5	1 25	29.43	96	.15	8.853628	29.58	1.146372	55
6	91	29.30	87	.15	.855403	29.47	.144597	54
7	49	29.20	78	.15	.857171	29.35	.142829	53
8	01	29.08	69	.15	.858932	29.23	.141068	52
9	46	28.95	60	.15	.860686	29.12	.139314	51
10	8. 83	28.85	9 51	.17	8.862433	29.00	1.137567	50
11	. 14	28.73	41	.15	.864173	28.88	.135827	49
12	. 38	28.62	32	.15	.865906	28.77	.134094	48
13	. 55	28.50	23	.17	.867632	28.65	.132368	47
14	. 65	28.38	13	.15	.869351	28.55	.130649	46
15	8. 68	28.28	9 04	.15	8.871064	28.43	1.128936	45
16	. 65	28.17	95	.17	.872770	28.32	.127230	44
17	. 55	28.05	85	.15	.874469	28.22	.125531	43
18	. 38	27.95	76	.17	.876162	28.12	.123838	42
19	. 15	27.83	66	.15	.877849	28.00	.122151	41
20	8. 85	27.73	9.998757	.17	8.879529	27.88	1.120471	40
21	. 49	27.63	.998747	.15	.881202	27.78	.118798	39
22	. 07	27.52	.998738	.17	.882869	27.68	.117131	38
23	. 58	27.42	.998728	.17	.884530	27.58	.115470	37
24	. 03	27.32	.998718	.17	.886185	27.47	.113815	36
25	8. 42	27.20	9.998708	.15	8.887833	27.38	1.112167	35
26	. 74	27.12	.998699	.17	.889476	27.27	.110524	34
27	. 01	27.00	.998689	.17	.891112	27.17	.108888	33
28	. 21	26.90	.998679	.17	.892742	27.07	.107258	32
29	. 35	26.80	.998669	.17	.894366	26.97	.105634	31
30	8.8 43	26.72	9.998659	.17	8.895984	26.87	1.104016	30
31	.8 46	26.60	.998649	.17	.897596	26.78	.102404	29
32	.8 42	26.50	.998639	.17	.899203	26.67	.100797	28
33	.8 32	26.42	.998629	.17	.900803	26.58	.099197	27
34	.9 17	26.32	.998619	.17	.902398	26.48	.097602	26
35	8.9 96	26.22	9.998609	.17	8.903987	26.38	1.096013	25
36	.9 69	26.12	.998599	.17	.905570	26.28	.094430	24
37	.9 36	26.02	.998589	.18	.907147	26.20	.092853	23
38	.9 97	25.93	.998578	.17	.908719	26.10	.091281	22
39	.9 53	25.85	.998568	.17	.910285	26.02	.089715	21
40	8.910404	25.75	58	.17	8.911846	25.92	1.088154	20
41	.911949	25.65	48	.18	.913401	25.83	.086599	19
42	.913488	25.57	37	.17	.914951	25.73	.085049	18
43	.915022	25.47	27	.18	.916495	25.65	.083505	17
44	.916550	25.38	16	.17	.918034	25.57	.081966	16
45	8.918073	25.30	06	.18	8.919568	25.47	1.080432	15
46	.919591	25.20	95	.17	.921096	25.38	.078904	14
47	.921103	25.12	85	.18	.922619	25.28	.077381	13
48	.922610	25.03	74	.17	.924136	25.22	.075864	12
49	.924112	24.95	64	.18	.925649	25.12	.074351	11
50	8.925609	24.85	9.998453	.18	8.927156	25.03	1.072844	10
51	.927100	24.78	.998442	.18	.928658	24.95	.071342	9
52	.928587	24.68	.998431	.17	.930155	24.87	.069845	8
53	.930068	24.60	.998421	.18	.931647	24.78	.068353	7
54	.931544	24.52	10	.18	.933134	24.70	.066866	6
55	8.933015	24.43	99	.18	8.934616	24.62	1.065384	5
56	.934481	24.35	88	.18	.936093	24.53	.063907	4
57	.935942	24.27	77	.18	.937565	24.45	.062435	3
58	.937398	24.20	66	.18	.939032	24.37	.060968	2
59	.938850	24.10	55	.18	.940494	24.30	.059506	1
60	8.940296		44		8.941952		1.058048	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	8.940296	24.03	9.998344	.18	8.941952	24.20	1.058048	60
1	.941738	23.93	.998333	.18	.943404	24.13	.056596	59
2	.943174	23.87	.998322	.18	.944852	24.05	.055148	58
3	.944606	23.80	.998311	.18	.946295	23.98	.053705	57
4	.946034	23.70	.998300	.18	.947734	23.90	.052266	56
5	8.947456	23.63	9.998289	.20	8.949168	23.82	1.050832	55
6	.948874	23.55	.998277	.18	.950597	23.73	.049403	54
7	.950287	23.48	.998266	.18	.952021	23.67	.047979	53
8	.951696	23.40	.998255	.20	.953441	23.58	.046559	52
9	.953100	23.32	.998243	.18	.954856	23.52	.045144	51
10	8. 99	23.25	9.998232	.20	8.956267	23.45	1.043733	50
11	. 94	23.17	.998220	.18	.957674	23.35	.042326	49
12	. 84	23.10	.998209	.20	.959075	23.30	.040925	48
13	. 70	23.03	.998197	.18	.960473	23.22	.039527	47
14	. 52	22.95	.998186	.20	.961866	23.15	.038134	46
15	8. 29	22.87	9.998174	.18	8.963255	23.07	1.036745	45
16	. 01	22.82	.998163	.20	.964639	23.00	.035361	44
17	. 70	22.73	.998151	.20	.966019	22.92	.033981	43
18	. 34	22.65	.998139	.18	.967394	22.87	.032606	42
19	. 93	22.60	.998128	.20	.968766	22.78	.031234	41
20	8.968249	22.52	9.998116	.20	8.970133	22.72	1.029867	40
21	.969600	22.45	.998104	.20	.971496	22.65	.028504	39
22	.970947	22.37	.998092	.20	.972855	22.57	.027145	38
23	.972289	22.32	.998080	.20	.974209	22.52	.025791	37
24	.973628	22.23	.998068	.20	.975560	22.43	.024440	36
25	8.974962	22.18	9.998056	.20	8.976906	22.37	1.023094	35
26	.976293	22.10	.998044	.20	.978248	22.30	.021752	34
27	.977619	22.03	.998032	.20	.979586	22.25	.020414	33
28	.978941	21.97	.998020	.20	.980921	22.17	.019079	32
29	.980259	21.90	.998008	.20	.982251	22.10	.017749	31
30	8.981573	21.83	9.997996	.20	8.983577	22.03	1.016423	30
31	.982883	21.77	.997984	.20	.984899	21.97	. 01	29
32	.984189	21.70	.997972	.22	.986217	21.92	. 83	28
33	.985491	21.63	.997959	.20	.987532	21.83	. 68	27
34	.986789	21.57	.997947	.20	.988842	21.78	. 58	26
35	8.988083	21.52	9.997935	.22	8.990149	21.70	1. 51	25
36	.989374	21.43	.997922	.20	.991451	21.65	. 49	24
37	.990660	21.38	.997910	.22	.992750	21.58	. 50	23
38	.991943	21.32	.997897	.20	.994045	21.53	. 55	22
39	.993222	21.25	.997885	.22	.995337	21.45	. 63	21
40	8.994497	21.18	9.997872	.20	8.996624	21.40	1.003376	20
41	.995768	21.13	.997860	.22	.997908	21.33	.002092	19
42	.997036	21.05	.997847	.20	.999188	21.28	.000812	18
43	.998299	21.02	.997835	.22	9.000465	21.22	0.999535	17
44	.999560	20.93	.997822	.22	.001738	21.15	.998262	16
45	9.000816	20.88	9.997809	.20	9.003007	21.08	0.996993	15
46	.002069	20.82	.997797	.22	.004272	21.03	.995728	14
47	.003318	20.75	.997784	.22	.005534	20.97	.994466	13
48	.004563	20.70	.997771	.22	.006792	20.92	.993208	12
49	.005805	20.65	.997758	.22	.008047	20.85	.991953	11
50	9.007044	20.57	9.997745	.22	9.009298	20.80	0.990702	10
51	.008278	20.53	.997732	.22	.010546	20.73	.989454	9
52	.009510	20.45	.997719	.22	.011790	20.68	.988210	8
53	.010737	20.42	.997706	.22	.013031	20.62	.986969	7
54	.011962	20.33	.997693	.22	.014268	20.57	.985732	6
55	9.013182	20.30	9.997680	.22	9.015502	20.50	0.984498	5
56	.014400	20.22	.997667	.22	.016732	20.45	.983268	4
57	.015613	20.18	.997654	.22	.017959	20.40	.982041	3
58	.016824	20.12	.997641	.22	.019183	20.33	.980817	2
59	.018031	20.07	.997628	.23	.020403	20.28	.979597	1
60	9.019235		9.997614		9.021620		0.978380	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

95° 84°

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.019235	20.00	9.997614	.22	9.021620	20.23	0.978380	[illegible]
1	.020435	19.95	.997601	.22	.022834	20.17	.977166	59
2	.021632	19.88	.997588	.23	.024044	20.12	.975956	58
3	.022825	19.85	.997574	.22	.025251	20.07	.974749	57
4	.024016	19.78	.997561	.23	.026455	20.00	.973545	56
5	9.025203	19.72	9.997547	.22	9.027655	19.95	0.972345	55
6	.026386	19.68	.997534	.23	.028852	19.90	.971148	54
7	.027567	19.62	.997520	.22	.030046	19.85	.969954	53
8	.028744	19.57	.997507	.23	.031237	19.80	.968763	52
9	.029918	19.52	.997493	.22	.032425	19.73	.967575	51
10	9.031089	19.47	9.997480	.23	9.033609	19.70	0.966391	50
11	.032257	19.40	.997466	.23	.034791	19.63	.965209	49
12	.033421	19.35	.997452	.22	.035969	19.58	.964031	48
13	.034582	19.32	.997439	.23	.037144	19.53	.962856	47
14	.035741	19.25	.997425	.23	.038316	19.48	.961684	46
15	9.036896	19.20	9.997411	.23	9.039485	19.43	0.960515	45
16	.038048	19.15	.997397	.23	.040651	19.37	.959349	44
17	.039197	19.08	.997383	.23	.041813	19.33	.958187	43
18	.040342	19.05	.997369	.23	.042973	19.28	.957027	42
19	.041485	19.00	.997355	.23	.044130	19.23	.955870	41
20	9.042625	18.95	9.997341	.23	9.045284	19.17	0.954716	40
21	.043762	18.88	.997327	.23	.046434	19.13	.953566	39
22	.044895	18.85	.997313	.23	.047582	19.08	.952418	38
23	.046026	18.80	.997299	.23	.048727	19.03	.951273	[illegible]
24	.047154	18.75	.997285	.23	.049869	18.98	.950131	[illegible]
25	9.048279	18.68	9.997271	.23	9.051008	18.93	0.948992	[illegible]
26	.049400	18.65	.997257	.25	.052144	18.88	.947856	34
27	.050519	18.60	.997242	.23	.053277	18.83	.946723	33
28	.051635	18.57	.997228	.23	.054407	18.80	.945593	32
29	.052749	18.50	.997214	.25	.055535	18.73	.944465	31
30	9.053859	18.45	9.997199	.23	9.056659	18.70	0.943341	30
31	.054966	18.42	.997185	.25	.057781	18.65	.942219	29
32	.056071	18.35	.997170	.23	.058900	18.60	.941100	28
33	.057172	18.32	.997156	.25	.060016	18.57	.939984	27
34	.058271	18.27	.997141	.23	.061130	18.50	.938870	26
35	9.059367	18.22	9.997127	.25	9.062240	18.47	0.937760	25
36	.060460	18.18	.997112	.23	.063348	18.42	.936652	24
37	.061551	18.13	.997098	.25	.064453	18.38	.935547	23
38	.062639	18.08	.997083	.25	.065556	18.32	.934444	22
39	.063724	18.03	.997068	.25	.066655	18.28	.933345	21
40	9.064806	17.98	9.997053	.23	9.067752	18.23	0.932248	20
41	.065885	17.95	.997039	.25	.068846	18.20	.931154	19
42	.066962	17.90	.997024	.25	.069938	18.15	.930062	18
43	.068036	17.85	.997009	.25	.071027	18.10	.928973	17
44	.069107	17.82	.996994	.25	.072113	18.07	.927887	16
45	9.070176	17.77	9.996979	.25	9.073197	18.02	0.926803	15
46	.071242	17.73	.996964	.25	.074278	17.97	.925722	14
47	.072306	17.67	.996949	.25	.075356	17.93	.924644	13
48	.073366	17.63	.996934	.25	.076432	17.88	.923568	12
49	.074424	17.60	.996919	.25	.077505	17.85	.922495	11
50	9.[illegible]80	17.55	9.996904	.25	9.078576	17.80	0.921424	10
51	.[illegible]33	17.50	.996889	.25	.079644	17.77	.920356	9
52	.[illegible]83	17.47	.996874	.27	.080710	17.72	.919290	8
53	.[illegible]31	17.42	.996858	.25	.081773	17.67	.918227	7
54	.[illegible]76	17.38	.996843	.25	.082833	17.63	.917167	6
55	9.[illegible]19	17.33	9.996828	.27	9.083891	17.60	0.916109	5
56	.[illegible]59	17.30	.996812	.25	.084947	17.55	.915053	4
57	.[illegible]97	17.25	.996797	.25	.086000	17.50	.914000	3
58	.[illegible]32	17.20	.996782	.27	.087050	17.47	.912950	2
[illegible]	.[illegible]64	17.17	.996766	.25	.088098	17.43	.911902	1
60	9.[illegible]94		9.996751		9.089144		0.910856	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M.

96° 83°

M.	Sin.	D. 1''.	Cos.					
0	9.085894	17.13	51	.27	9.089144	17.38	0.910856	60
1	.086922	17.08	35	.25	.090187	17.35	.909813	59
2	.087947	17.05	20	.27	.091228	17.30	.908772	58
3	.088970	17.00	04	.27	.092266	17.27	.907734	57
4	.089990	16.97	88	.25	093302	17.23	.906698	56
5	9.091008	16.93	73	.27	9.094336	17.18	0.905664	55
6	.092024	16.88	57	.27	.095367	17.13	.904633	54
7	.093037	16.83	41	.27	.096395	17.12	.903605	53
8	.094047	16.82	25	.25	.097422	17.07	.902578	52
9	.095056	16.77	10	.27	.098446	17.03	.901554	51
10	9.096062	16.72	9 34	.27	9.099468	16.98	0.900532	50
11	.097065	16.68	78	.27	.100487	16.95	.899513	49
12	.098066	16.65	52	.27	.101504	16.92	.898496	48
13	.099065	16.62	46	.27	.102519	16.88	.897481	47
14	.100062	16.57	30	.27	.103532	16.83	.896468	46
15	9.101056	16.53	9 14	.27	9.104542	16.80	0.895458	45
16	.102048	16.48	98	.27	.105550	16.77	.894450	44
17	.103037	16.47	82	.28	.106556	16.72	.893444	43
18	.104025	16.42	65	.27	.107559	16.68	.892441	42
19	.105010	16.37	49	.27	.108560	16.65	.891440	41
20	9.105992	16.35	5 33	.27	9.109539	16.62	0.890441	40
21	.106973	16.30	17	28	.110556	16.58	.889444	39
22	.107951	16.27	00	.27	.111551	16.53	.888449	38
23	.108927	16.23	84	.27	.112543	16.50	.887457	37
24	.109901	16.20	68	.28	.113533	16.47	.886467	36
25	9.110873	16.15	5 51	.27	9.114521	16.43	0.885479	35
26	.111842	16.12	35	.28	.115507	16.40	.884493	34
27	.112809	16.08	18	.27	.116491	16.35	.883509	33
28	.113774	16.05	02	.28	.117472	16.33	.882528	32
29	.114737	16.02	85	.27	.118452	16.28	.881548	31
30	9.115698	15.97	9.996269	.28	9.119429	16.25	0 71	30
31	.116656	15.95	.996252	.28	.120404	16.22	96	29
32	.117613	15.90	.996235	.27	.121377	16.18	23	28
33	.118567	15.87	.996219	.28	.122348	16.15	52	27
34	.119519	15.83	.996202	.28	.123317	16.12	83	26
35	9.120469	15.80	9.996185	.28	9.124284	16.08	0 16	25
36	.121417	15.75	.996168	.28	.125249	16.03	51	24
37	.122362	15.73	.996151	.28	.126211	16.02	89	23
38	.123306	15.70	.996134	.28	.127172	15.97	[illegible]28	22
39	.124248	15.65	.996117	.28	.128130	15.95	.871870	21
40	9.125187	15.63	9.996100	.28	9.129087	15.90	0.870913	20
41	.126125	15.58	.996083	.28	.130041	15.88	.869959	19
42	.127060	15.55	.996066	.28	.130994	15.83	.869006	18
43	.127993	15.53	.996049	.28	.131944	15.82	.868056	17
44	.128925	15.48	.996032	.28	.132893	15.77	.867107	16
45	9.129854	15.45	9.996015	.28	9.133839	15.75	0.866161	15
46	.130781	15.42	.995998	.30	.134784	15.70	.865216	14
47	.131706	15.40	.995980	.28	.135726	15.68	.864274	13
48	.132630	15.35	.995963	.28	.136667	15.63	.863333	12
49	.133551	15.32	.995946	.30	.137605	15.62	.862395	11
50	9.134470	15.28	9. 28	.28	9.138542	15.57	0.861458	10
51	.135387	15.27	. 11	.28	.139476	15.55	.860524	9
52	.136303	15.22	. 94	.30	.140409	15.52	.859591	8
53	.137216	15.20	. 76	.28	.141340	15.48	.858660	7
54	.138128	15.15	. 59	.30	.142269	15.45	.857731	6
55	9.139037	15.12	9. 41	.30	9.143196	15.42	0.856804	5
56	.139944	15.10	. 23	.28	.144121	15.38	.855879	4
57	.140850	15.07	. 06	.30	.145044	15.37	.854956	3
58	.141754	15.02	[illegible]88	.28	.145966	15.32	.854034	2
59	.142655	15.00	.995771	.30	.146885	15.30	.853115	1
60	9.143555		9.995753		9.147803		0.842107	0
				′.				M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.143555	14.97	9.995753	.30	9.147803	15.25	0.852197	60
1	.144453	14.93	.995735	.30	.148718	15.23	.851282	59
2	.145349	14.90	.995717	.30	.149632	15.20	.850368	58
3	.146243	14.88	.995699	.30	.150544	15.17	.849456	57
4	.147136	14.83	.995681	.28	.151454	15.15	.848546	56
5	9.148026	14.82	9.995664	.30	9.152363	15.10	0.847637	55
6	.148915	14.78	.995646	.30	.153269	15.08	.846731	54
7	.149802	14.73	.995628	.30	.154174	15.05	.845826	53
8	.150686	14.72	.995610	.32	.155077	15.02	.844923	52
9	.151569	14.70	.995591	.30	.155978	14.98	.844022	51
10	9.152451	14.65	9.995573	.30	9.156877	14.97	0.843123	50
11	.153330	14.63	.995555	.30	.157775	14.93	.842225	49
12	.154208	14.58	.995537	.30	.158671	14.90	.841329	48
13	.155083	14.57	.995519	.30	.159565	14.87	.840435	47
14	.155957	14.55	.995501	.32	.160457	14.83	.839543	46
15	9.156830	14.50	9.995482	.30	9.161347	14.82	0.838653	45
16	.157700	14.48	.995464	.30	.162236	14.78	.837764	44
17	.158569	14.43	.995446	.32	.163123	14.75	.836877	43
18	.159435	14.43	.995427	.30	.164008	14.73	.835992	42
19	.160301	14.38	.995409	.32	.164892	14.70	.835108	41
20	9.161164	14.35	9.995390	.30	9.165774	14.67	0.834226	40
21	.162025	14.33	.995372	.32	.166654	14.63	.833346	39
22	.162885	14.30	.995353	.32	.167532	14.62	.832468	38
23	.163743	14.28	.995334	.30	.168409	14.58	.831591	37
24	.164600	14.23	.995316	.32	.169284	14.55	.830716	36
25	9.165454	14.22	9.995297	.32	9.170157	14.53	0.829843	35
26	.166307	14.20	.995278	.30	.171029	14.50	.828971	34
27	.167159	14.15	.995260	.32	.171899	14.47	.828101	33
28	.168008	14.13	.995241	.32	.172767	14.45	.827233	32
29	.168856	14.10	.995222	.32	.173634	14.42	.826366	31
30	9.169702	14.08	9.995203	.32	9.174499	14.38	0.825501	30
31	.170547	14.03	.995184	.32	.175362	14.37	.824638	29
32	.171389	14.02	.995165	.32	.176224	14.33	.823776	28
33	.172230	14.00	.995146	.32	.177084	14.30	.822916	27
34	.173070	13.97	.995127	.32	.177942	14.28	.822058	26
35	9.173908	13.93	9.995108	.32	9.178799	14.27	0.821201	25
36	.174744	13.90	.995089	.32	.179655	14.22	.820345	24
37	.175578	13.88	.995070	.32	.180508	14.20	.819492	23
38	.176411	13.85	.995051	.32	.181360	14.18	.818640	22
39	.177242	13.83	.995032	.32	.182211	14.13	.817789	21
40	9.178072	13.80	9.995013	.33	9.183059	14.13	0.816941	20
41	.178900	13.77	.994993	.32	.183907	14.08	.816093	19
42	.179726	13.75	.994974	.32	.184752	14.08	.815248	18
43	.180551	13.72	.994955	.33	.185597	14.03	.814403	17
44	.181374	13.70	.994935	.32	.186439	14.02	.813561	16
45	9.182196	13.67	9.994916	.33	9.187280	14.00	0.812720	15
46	.183016	13.63	.994896	.32	.188120	13.97	.811880	14
47	.183834	13.62	.994877	.33	.188958	13.93	.811042	13
48	.184651	13.58	.994857	.32	.189794	13.92	.810206	12
49	.185466	13.57	.994838	.33	.190629	13.88	.809371	11
50	9.186280	13.53	9.994818	.33	9.191462	13.87	0.808538	10
51	.187092	13.52	.994798	.32	.192294	13.83	.807706	9
52	.187903	13.48	.994779	.33	.193124	13.82	.806876	8
53	.188712	13.45	.994759	.33	.193953	13.78	.806047	7
54	.189519	13.43	.994739	.32	.194780	13.77	.805220	6
55	9.190325	13.42	9.994720	.33	9.195606	13.73	0.804394	5
56	.191130	13.38	.994700	.33	.196430	13.72	.803570	4
57	.191933	13.35	.994680	.33	.197253	13.68	.802747	3
58	.192734	13.33	.994660	.33	.198074	13.67	.801926	2
59	.193534	13.30	.994640	.33	.198894	13.65	.801106	1
60	9.194332		9.994620		9.199713		0.800287	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.194332	13.28	9.994620	.33	9.199713	13.60	0.800287	60
1	.195129	13.27	.994600	.33	.200529	13.60	.799471	59
2	.195925	13.23	.994580	.33	.201345	13.57	.798655	58
3	.196719	13.20	.994560	.33	.202159	13.53	.797841	57
4	.197511	13.18	.994540	.35	.202971	13.52	.797029	56
5	9.198302	13.15	9.994519	.33	9.203782	13.50	0.796218	55
6	199091	13.13	.994499	.33	.204592	13.47	.795408	54
7	.199879	13.12	.994479	.33	.205400	13.45	.794600	53
8	200666	13.08	.994459	.35	.206207	13.43	.793793	52
9	.201451	13.05	.994438	.33	.207013	13.40	.792987	51
10	9.202234	13.05	9.994418	.33	9.207817	13.37	83	50
11	.203017	13.00	.994398	.35	.208619	13.35	81	49
12	.203797	13.00	.994377	.33	.209420	13.33	80	48
[redacted]	.204577	12.95	.994357	.35	.210220	13.30	80	47
14	.205354	12.95	.994336	.33	.211018	13.28	82	46
15	9.206131	12.92	9.994316	.35	9.211815	13.27	85	45
16	.206906	12.88	.994295	.35	.212611	13.23	89	44
17	207679	12.88	.994274	.33	.213405	13.22	95	43
18	.208452	12.83	.994254	.35	.214198	13.18	02	42
19	209222	12.83	.994233	.35	.214989	13.18	11	41
20	9.209992	12.80	9.994212	.35	9.215780	13.13	0.784220	40
21	.210760	12.77	.994191	.33	.216568	13.13	.783432	39
22	.211526	12.75	.994171	.35	.217356	13.10	.782644	38
23	.212291	12.73	.994150	.35	.218142	13.07	.781858	37
24	.213055	12.72	.994129	.35	.218926	13.07	.781074	36
25	9.213818	12.68	9.994108	.35	9.219710	13.03	0.780290	35
26	.214579	12.65	.994087	.35	.220492	13.[redacted]	.779508	34
27	.215338	12.65	.994066	.35	.221272	13.00	.778728	33
28	.216097	12.62	.994045	.35	.222052	12.97	.777948	32
29	.216854	12.58	.994024	.35	.222830	12.95	.777170	31
30	9.217609	12.57	9.994003	.35	9.223607	12.92	0.776393	30
31	.218363	12.55	.993982	.37	.224382	12.90	.775618	29
32	.219116	12.53	.993960	.35	.225156	12.88	.774844	28
33	.219868	12.50	.993939	.35	.225929	12.85	.774071	27
34	.220618	12.48	.993918	.35	.226700	12.85	.773300	26
35	9.221367	12.47	9.993897	.37	9.227471	12.80	0.772529	25
36	.222115	12.43	.993875	.35	.228239	12.80	.771761	24
37	.222861	12.42	.993854	.37	.229007	12.77	.770993	23
38	.223606	12.38	.993832	.35	.229773	12.77	.770227	22
39	.224349	12.38	.993811	.37	.230539	12.72	.769461	21
40	9.225092	12.35	9.993789	.35	9.231302	12.72	0. 98	20
41	.225833	12.33	.993768	.37	.232065	12.68	. 35	19
42	.226573	12.30	.993746	.35	.232826	12.67	. 74	18
43	.227311	12.28	.993725	.37	.233586	12.65	. 14	17
44	.228048	12.27	.993703	.37	.234345	12.63	. 55	16
45	9.228784	12.23	9.993681	.35	9.235103	12.60	0. 97	15
46	.229518	12.23	.993660	.37	.235859	12.58	. 41	14
47	.230252	12.20	.993638	.37	.236614	12.57	. 86	13
48	.230984	12.18	.993616	.37	.237368	12.53	. 32	12
49	.231715	12.15	.993594	.37	.238120	12.53	. 80	11
50	9.232444	12.13	9.993572	.37	9.238872	12.50	0.761128	10
51	.233172	12.12	.993550	.37	.239622	12.48	.760378	9
52	.233899	12.10	.993528	.37	.240371	12.45	.759629	8
53	234625	12.07	.993506	.37	.241118	12.45	758882	7
54	.235349	12.07	.993484	.37	.241865	12.42	.758135	6
55	9.236073	12.03	9.993462	.37	9.242610	12.40	0.757390	5
56	.236795	12.00	.993440	.37	.243354	12.38	.756646	4
57	.237515	12.00	.993418	.37	.244097	12.37	.755903	3
58	.238235	11.97	.993396	.37	.244839	12.33	.755161	2
59	.238953	11.95	.993374	.38	.245579	12.33	.754421	1
60	9.239670		9.993351		9.246319		0.753681	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.239670	11.93	9.993351	.37	9.246319	12.30	0.753681	60
1	.240386	11.92	.993329	.37	.247057	12.28	.752943	59
2	.241101	11.88	.993307	.38	.247794	12.27	.752206	58
3	.241814	11.87	.993284	.37	.248530	12.23	.751470	57
4	.242526	11.85	.993262	.37	.249264	12.23	.750736	56
5	9.243237	11.83	9.993240	.38	9.249998	12.20	0.750002	55
6	.243947	11.82	.993217	.37	.250730	12.18	.749270	54
7	.244656	11.78	.993195	.38	.251461	12.17	.748539	53
8	.245363	11.77	.993172	.38	.252191	12.15	.747809	52
9	.246069	11.77	.993149	.37	.252920	12.13	.747080	51
10	9.246775	11.72	9.993127	.38	9.253648	12.10	0.746352	50
11	.247478	11.72	.993104	.38	.254374	12.10	.745626	49
12	.248181	11.70	.993081	.37	.255100	12.07	.744900	48
13	.248883	11.67	.993059	.38	.255824	12.05	.744176	47
14	.249583	11.65	.993036	.38	.256547	12.03	.743453	46
15	9.250282	11.63	9.993013	.38	9.257269	12.02	0.742731	45
16	.250980	11.62	.992990	.38	.257990	12.00	.742010	44
17	.251677	11.60	.992967	.38	.258710	11.98	.741290	43
18	.252373	11.57	.992944	.38	.259429	11.95	.740571	42
19	.253067	11.57	.992921	.38	.260146	11.95	.739854	41
20	9.253761	11.53	9.992898	.38	9.260863	11.92	0.739137	40
21	.254453	11.52	.992875	.38	.261578	11.90	.738422	39
22	.255144	11.50	.992852	.38	.262292	11.88	.737708	38
23	.255834	11.48	.992829	.38	.263005	11.87	.736995	37
24	.256523	11.47	.992806	.38	.263717	11.85	.736283	36
25	9.257211	11.45	9.992783	.40	9.264428	11.83	0.735572	35
26	.257898	11.42	.992759	.38	.265138	11.82	.734862	34
27	.258583	11.42	.992736	.38	.265847	11.80	.734153	33
28	.259268	11.38	.992713	.38	.266555	11.77	.733445	32
29	.259951	11.37	.992690	.40	.267261	11.77	.732739	31
30	9.260633	11.35	9.992666	.38	9.267967	11.73	0.732033	30
31	.261314	11.33	.992643	.40	.268671	11.73	.731329	29
32	.261994	11.32	.992619	.38	.269375	11.70	.730625	28
33	.262673	11.30	.992596	.40	.270077	11.70	.729923	27
34	.263351	11.27	.992572	.38	.270779	11.67	.729221	26
35	9.264027	11.27	9.992549	.40	9.271479	11.65	0.728521	25
36	.264703	11.23	.992525	.40	.272178	11.63	.727822	24
37	.265377	11.23	.992501	.38	.272876	11.62	.727124	23
38	.266051	11.20	.992478	.40	.273573	11.60	.726427	22
39	.266723	11.20	.992454	.40	.274269	11.58	.725731	21
40	9.267395	11.17	9.992430	.40	9.274964	11.57	0.725036	20
41	.268065	11.15	.992406	.40	.275658	11.55	.724342	19
42	.268734	11.13	.992382	.38	.276351	11.53	.723649	18
43	.269402	11.12	.992359	.40	.277043	11.52	.722957	17
44	.270069	11.10	.992335	.40	.277734	11.50	.722266	16
45	9.270735	11.08	9.992311	.40	9.278424	11.48	0.721576	15
46	.271400	11.07	.992287	.40	.279113	11.47	.720887	14
47	.272064	11.03	.992263	.40	.279801	11.45	.720199	13
48	.272726	11.03	.992239	.42	.280488	11.43	.719512	12
49	.273388	11.02	.992214	.40	.281174	11.40	.718826	11
50	9.274049	10.98	9.992190	.40	9.281858	11.40	0.718142	10
51	.274708	10.98	.992166	.40	.282542	11.38	.717458	9
52	.275367	10.97	.992142	.40	.283225	11.37	.716775	8
53	.276025	10.93	.992118	.42	.283907	11.35	.716093	7
54	.276681	10.93	.992093	.40	.284588	11.33	.715412	6
55	9.277337	10.90	9.992069	.42	9.285268	11.32	0.714732	5
56	.277991	10.90	.992044	.40	.285947	11.28	.714053	4
57	.278645	10.87	.992020	.40	.286624	11.28	.713376	3
58	.279297	10.85	.991996	.42	.287301	11.27	.712699	2
59	.279948	10.85	.991971	.40	.287977	11.25	.712023	1
60	9.280599		9.991947		9.288652		0.711348	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.280599	10.82	9.991947	.42	9.288652	11.23	0.711348	60
1	.281248	10.82	.991922	.42	289326	11.22	.710674	59
2	.281897	10.78	.991897	.40	.289999	11.20	.710001	58
3	.282544	10.77	.991873	.42	.290671	11.18	.709329	57
4	.283190	10.77	.991848	.42	.291342	11.18	.708658	56
5	9.283836	10.73	9.991823	.40	9.292013	11.15	0.707987	55
6	.284480	10.73	.991799	.42	.292682	11.13	.707318	54
7	.285124	10.70	.991774	.42	.293350	11.12	.706650	53
8	.285766	10.70	.991749	.42	.294017	11.12	.705983	52
9	.286408	10.67	.991724	.42	.294684	11.08	.705316	51
10	9.287048	10.67	9.991699	.42	9.295349	11.07	0.704651	50
11	.287688	10.63	.991674	.42	.296013	11.07	.703987	49
12	.288326	10.63	.991649	.42	.296677	11.03	.703323	48
13	.288964	10.60	.991624	.42	.297339	11.03	.702661	47
14	.289600	10.60	.991599	.42	.298001	11.02	.701999	46
15	9.290236	10.57	9.991574	.42	9.298662	11.00	0.701338	45
16	.290870	10.57	.991549	.42	.299322	10.97	.700678	44
17	.291504	10.55	.991524	.43	.299980	10.97	.700020	43
18	.292137	10.52	.991498	.42	.300638	10.95	.699362	42
19	.292768	10.52	.991473	.42	.301295	10.93	.698705	41
20	9.293399	10.50	9.991448	.43	9.301951	10.93	0.698049	40
21	.294029	10.48	.991422	.42	.302607	10.90	.697393	39
22	.294658	10.47	.991397	.42	.303261	10.88	.696739	38
23	.295286	10.45	.991372	43	.303914	10.88	.696086	37
24	.295913	10.43	.991346	.42	.304567	10.85	.695433	36
25	9.296539	10.42	9.991321	43	9.305218	10.85	0.694782	35
26	297164	10.40	.991295	.42	.305869	10.83	.694131	34
27	.297788	10.40	.991270	.43	.306519	10.82	.693481	33
28	.298412	10.37	.991244	.43	.307168	10.80	.692832	32
29	.299034	10.35	.991218	.42	.307816	10.78	.692184	31
30	9.299655	10.35	9.991193	.43	9.308463	10.77	0.691537	30
31	.300276	10.32	.991167	.43	.309109	10.75	.690891	29
32	.300895	10.32	.991141	43	.309754	10.75	.690246	28
33	.301514	10.30	.991115	.42	.310399	10.72	.689601	27
34	.302132	10.27	.991090	.43	.311042	10.72	.688958	26
35	9.302748	10.27	9.991064	.43	9.311685	10.70	0.688315	25
36	.303364	10.25	.991038	43	.312327	10.68	.687673	24
37	.303979	10.23	.991012	.43	.312968	10.67	.687032	23
38	.304593	10.23	.990986	.43	.313608	10.65	.686392	22
39	.305207	10.20	.990960	.43	.314247	10.63	.685753	21
40	9.305819	10.18	9.990934	.43	9.314885	10.63	0.[illegible]115	20
41	.306430	10.18	.990908	.43	.315523	10.60	.[illegible]477	19
42	.307041	10.15	.990882	.45	.316159	10.60	.[illegible]841	18
43	.307650	10.15	.990855	.43	.316795	10.58	.[illegible]205	17
44	.308259	10.13	.990829	.43	.317430	10.57	.[illegible]570	16
45	9.308867	10.12	9.990803	.43	9.318064	10.55	0.[illegible]936	15
46	.309474	10.10	990777	.45	.318697	10.55	.[illegible]303	14
47	.310080	10.08	.990750	43	.319330	10.52	.[illegible]670	13
48	.310685	10.07	.990724	.45	.319961	10.52	.[illegible]039	12
49	.311289	10.07	.990697	.43	.320592	10.50	.[illegible]408	11
50	9.311893	10.03	9.990671	.43	9.321222	10.48	0.678778	10
51	.312495	10.03	.990645	.45	.321851	10.47	.678149	9
52	.313097	10.02	.990618	.45	.322479	10.45	.677521	8
53	.313698	9.98	.990591	.43	.323106	10.45	.676894	7
54	.314297	10.00	.990565	.45	.323733	10.42	.676267	6
55	9.314897	9.97	9.990538	.45	9.324358	10.42	0.675642	5
56	.315495	9.95	.990511	.43	324983	10.40	.675017	4
57	.316092	9.95	.990485	.45	.325607	10.40	.674393	3
58	.316689	9.92	.990458	.45	326231	10.37	.673769	2
59	.317284	9.92	.990431	.45	.326853	10.37	.673147	1
60	9.317879		9.990404		9.327475		0.672525	0
	Cos.	D. 1″	Sin.	D. 1″	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.317879	9.90	9.990404	.43	9.327475	10.33	0.672525	60
1	.318473	9.88	.990378	.45	.328095	10.33	.671905	59
2	.319066	9.87	.990351	.45	.328715	10.32	.671285	58
3	.319658	9.85	.990324	.45	.329334	10.32	.670666	57
4	.320249	9.85	.990297	.45	.329953	10.28	.670047	56
5	9.320840	9.83	9.990270	.45	9.330570	10.28	0.669430	55
6	.321430	9.82	.990243	.47	.331187	10.27	.668813	54
7	.322019	9.80	.990215	.45	.331803	10.25	.668197	53
8	.322607	9.78	990188	.45	.332418	10.25	.667582	52
9	.323194	9.77	.990161	.45	.333033	10.22	.666967	51
10	9.323780	9.77	9.990134	.45	9.333646	10.22	0.666354	50
11	.324366	9.73	.990107	.47	.334259	10.20	.665741	49
12	.324950	9.73	.990079	.45	.334871	10.18	.665129	48
13	.325534	9.72	.990052	.45	.335482	10.18	.664518	47
14	.326117	9.72	.990025	.47	.336093	10.15	.663907	46
15	9.326700	9.68	9.989997	45	9.336702	10.15	0.663298	45
16	.327281	9.68	.989970	.47	.337311	10.13	.662689	44
17	.327862	9.67	.989942	.45	.337919	10.13	.662081	43
18	.328442	9.65	.989915	.47	.338527	10.10	.661473	42
19	.329021	9.63	.989887	.45	.339133	10.10	.660867	41
20	9.329599	9.62	9.989860	.47	9.339739	10.08	0.660261	40
21	.330176	9.62	.989832	.47	.340344	10.07	.659656	39
22	.330753	9.60	.989804	.45	.340948	10.07	.659052	38
23	.331329	9.57	.989777	.47	.341552	10.05	.658448	37
24	.331903	9.58	.989749	.47	.342155	10.03	.657845	36
25	9.332478	9.55	9.989721	.47	9.342757	10.02	0.657243	35
26	.333051	9.55	.989693	.47	.343358	10.00	.656642	34
27	.333624	9.52	.989665	.47	.343958	10.00	.656042	33
28	.334195	9.53	.989637	.45	.344558	9.98	.655442	32
29	.334767	9.50	.989610	.47	.345157	9.97	.654843	31
30	9.335337	9.48	9.989582	.48	9.345755	9.97	0.654245	30
31	.335906	9.48	.989553	.47	.346353	9.93	.653647	29
32	.336475	9.47	.989525	.47	.346949	9.93	.653051	28
33	.337043	9.45	.989497	.47	.347545	9.93	.652455	27
34	.337610	9.43	.989469	.47	.348141	9.90	.651859	26
35	9.338176	9.43	9.989441	.47	9.348735	9.90	0.651265	25
36	.338742	9.42	.989413	.47	.349329	9.88	.650671	24
37	.339307	9.40	.989385	.48	.349922	9.87	.650078	23
38	.339871	9.38	.989356	.47	.350514	9.87	.649486	22
39	.340434	9.37	.989328	.47	.351106	9.85	.648894	21
40	9.340996	9.37	9.989300	.48	9.351697	9.83	0.648303	20
41	.341558	9.35	.989271	.47	.352287	9.82	.647713	19
42	.342119	9.33	.989243	.48	.352876	9.82	.647124	18
43	.342679	9.33	.989214	.47	.353465	9.80	.646535	17
44	.343239	9.30	.989186	.48	.354053	9.78	.645947	16
45	9.343797	9.30	9.989157	.48	9.354640	9.78	0.645360	15
46	.344355	9.28	.989128	.47	.355227	9.77	.644773	14
47	.344912	9.28	.989100	.48	.355813	9.75	.644187	13
48	.345469	9.25	.989071	.48	.356398	9.73	.643602	12
49	.346024	9.25	.989042	.47	.356982	9.73	.643018	11
50	9.346579	9.25	9.989014	.48	9. 66	9.72	0.642434	10
51	.347134	9.22	.988985	.48	. 49	9.70	.641851	9
52	.347687	9.22	.988956	.48	. 31	9.70	.641269	8
53	.348240	9.20	.988927	48	. 13	9.67	.640687	7
54	.348792	9.18	.988898	.48	. 93	9.68	.640107	6
55	9.349343	9.17	9.988869	.48	9. 74	9.65	0.639526	5
56	.349893	9.17	.988840	.48	. 53	9.65	.638947	4
57	.350443	9.15	.988811	.48	. 32	9.63	.638368	3
58	.350992	9.13	.988782	.48	. 10	9.62	.637790	2
59	.351540	9.13	.988753	.48	. 87	9.62	.637213	1
60	9.352088		9.988724		9. 64		0.636636	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.352088	9.12	9.988724	.48	9.363364	9.60	0.636636	60
1	.352635	9.10	.988695	.48	.363940	9.58	.636060	59
2	.353181	9.08	.988666	.50	.364515	9.58	.635485	58
3	.353726	9.08	.988636	.48	.365090	9.57	.634910	57
4	.354271	9.07	.988607	.48	.365664	9.55	.634336	56
5	9.354815	9.05	9.988578	.50	9.366237	9.55	0.633763	55
6	.355358	9.05	.988548	.48	.366810	9.53	.633190	54
7	.355901	9.03	.988519	.50	.367382	9.52	.632618	53
8	.356443	9.02	.988489	.48	.367953	9.52	.632047	52
9	.356984	9.00	.988460	.50	.368524	9.50	.631476	51
10	9.357524	9.00	30	.48	9.369094	9.48	0.630906	50
11	.358064	8.98	01	.50	.369663	9.48	.630337	49
12	.358603	8.97	71	.48	.370232	9.45	.629768	48
13	.359141	8.95	42	.50	.370799	9.47	.629201	47
14	.359678	8.95	12	.50	.371367	9.43	.628633	46
15	9.360215	8.95	82	.50	9.371933	9.43	0.628067	45
16	.360752	8.92	52	.48	.372499	9.42	.627501	44
17	.361287	8.92	23	.50	.373064	9.42	.626936	43
18	.361822	8.90	93	.50	.373629	9.40	.626371	42
19	.362356	8.88	63	.50	.374193	9.38	.625807	41
20	9. 89	8.88	9.988133	.50	9.374756	9.38	0.625244	40
21	. 22	8.87	.988103	.50	.375319	9.37	.624681	39
22	. 54	8.85	.988073	.50	.375881	9.35	.624119	38
23	. 85	8.85	.988043	.50	.376442	9.35	.623558	37
24	. 16	8.83	.988013	.50	.377003	9.33	.622997	36
25	9. 46	8.82	9.987983	.50	9.377563	9.32	0.622437	35
26	. 75	8.82	.987953	.52	.378122	9.32	.621878	34
27	. 04	8.78	.987922	50	.378681	9.30	.621319	33
28	. 31	8.80	.987892	.50	.379239	9.30	.620761	32
29	. 59	8.77	.987862	.50	.379797	9.28	.620203	31
30	9.368185	8.77	9.987832	.52	9.380354	9.27	0.619646	30
31	.368711	8.75	987801	.50	.380910	9.27	.619090	29
32	.369236	8.75	.987771	52	.381466	9.23	.618534	28
33	.369761	8.73	987740	.50	.382020	9.25	.617980	27
34	370285	8.72	.987710	.52	.382575	9.23	.617425	26
35	9.370808	8.70	9.987679	.50	9.383129	9.22	0.616871	25
36	.371330	8.70	.987649	52	.383682	9.20	.616318	24
37	.371852	8.68	.987618	.50	.384234	9.20	.615766	23
38	.372373	8.68	.987588	52	.384786	9.18	.615214	22
39	.372894	8.67	.987557	.52	.385337	9.18	.614663	21
40	9.373414	8.65	9.987526	.50	9.385888	9.17	0.614112	20
41	.373933	8.65	987496	.52	.386438	9.15	.613562	19
42	.374452	8.63	.987465	.52	.386987	9.15	.613013	18
43	.374970	8.62	.987434	.52	.387536	9.13	.612464	17
44	.375487	8.60	.987403	.52	.388084	9.12	.611916	16
45	9.376003	8.60	9.987372	.52	9.388631	9.12	0.611369	15
46	.376519	8.60	.987341	.52	.389178	9.10	.610822	14
47	.377035	8.57	.987310	.52	.389724	9.10	.610276	13
48	.377549	8.57	.987279	.52	.390270	9.08	.609730	12
49	.378063	8.57	.987248	.52	.390815	9.08	.609185	11
50	9.378577	8.53	9.987217	.52	9.391360	9.05	0.608640	10
51	.379089	8.53	.987186	.52	.391903	9.07	.608097	9
52	.379601	8.53	.987155	.52	.392447	9.03	.607553	8
53	.380113	8.52	.987124	.53	.392989	9.03	.607011	7
54	.380624	8.50	.987092	.52	393531	9.03	.606469	6
55	9.381134	8.48	9.987061	52	9.394073	9.02	0.605927	5
56	.381643	8.48	.987030	.53	.394614	9.00	.605386	4
57	.382152	8.48	.986998	.52	.395154	9.00	.604846	3
58	.382661	8.45	.986967	.52	.395694	8.98	.604306	2
59	.383168	8.45	.986936	.53	.396233	8.97	.603767	1
60	9.383675		9.986904		9.396771		0.603229	0
	Cos.	D. 1".	Sin.	D. 1"				M.

M	Sin.	D. 1″	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.383675	8.45	9. 04	.52	9.396771	8.97	0.603229	60
1	.384182	8.42	. 73	.53	.397309	8.95	.602691	59
2	.384687	8.42	. 41	.53	.397846	8.95	.602154	58
3	.385192	8.42	. 09	.52	.398383	8.93	.601617	57
4	.385697	8.40	. 78	.53	.398919	8.93	601081	56
5	9.386201	8.38	9. 46	.53	9.399455	8.92	0.600545	55
6	.386704	8.38	. 14	.52	.399990	8.90	.600010	54
7	387207	8.37	. 83	.53	.400524	8.90	.599476	53
8	.387709	8.35	. 51	.53	.401058	8.88	.598942	52
9	.388210	8.35	. 19	.53	.401591	8.88	.598409	51
10	9.388711	8.33	9.986587	.53	9.402124	8.87	0.597876	50
11	.389211	8.33	.986555	.53	.402656	8.85	.597344	49
12	.389711	8.32	.986523	.53	.403187	8.85	.596813	48
13	.390210	8.30	.986491	.53	.403718	8.85	.596282	47
14	390708	8.30	.986459	.53	.404249	8.82	.595751	46
15	9.391206	8.28	9.986427	.53	9.404778	8.83	0.595222	45
16	.391703	8.27	.986395	.53	.405308	8.80	.594692	44
17	.392199	8.27	.986363	.53	.405836	8.80	.594164	43
18	.392695	8.27	.986331	.53	.406364	8.80	.593636	42
19	.393191	8.23	.986299	.55	.406892	8.78	.593108	41
20	9.393685	8.23	9.986266	.53	9.407419	8.77	0.592581	40
21	.394179	8.23	.986234	.53	.407945	8.77	.592055	39
22	.394673	8.22	.986202	.55	.408471	8.75	.591529	38
23	.395166	8.20	.986169	.53	.408996	8.75	.591004	37
24	.395658	8.20	.986137	.55	.409521	8.73	.590479	36
25	9.396150	8.18	9.986104	.53	9.410045	8.73	0.589955	35
26	.396641	8.18	.986072	.55	.410569	8.72	.589431	34
27	.397132	8.15	.986039	.53	.411092	8.72	.588908	33
28	.397621	8.17	.986007	55	.411615	8.70	.588385	32
29	.398111	8.15	.985974	.53	.412137	8.68	.587863	31
30	9.398600	8.13	9.985942	.55	9.412658	8.68	0.587342	30
31	.399088	8.12	.985909	.55	.413179	8.67	.586821	29
32	.399575	8.12	.985876	.55	.413699	8.67	.586301	28
33	.400062	8.12	.985843	.53	.414219	8.65	.585781	27
34	.400549	8.10	.985811	.55	.414738	8.65	.585262	26
35	9.401035	8.08	9.985778	.55	9.415257	8.63	0.584743	25
36	.401520	8.08	.985745	.55	415775	8.63	.584225	24
37	.402005	8.07	.985712	.55	.416293	8.62	.583707	23
38	.402489	8.05	.985679	.55	.416810	8.60	.583190	22
39	.402972	8.05	.985646	.55	.417326	8.60	.582674	21
40	9.403455	8.05	9.985613	.55	9.417842	8.60	0.582158	20
41	.403938	8.03	.985580	.55	.418358	8.58	.581642	19
42	.404420	8.02	.985547	.55	.418873	8.57	.581127	18
43	.404901	8.02	.985514	.57	.419387	8.57	.580613	17
44	.405382	8.00	.985480	.55	.419901	8.57	.580099	16
45	9.405862	7.98	9.985447	.55	9.420415	8.53	0.579585	15
46	.406341	7.98	.985414	.55	.420927	8.55	.579073	14
47	.406820	7.98	.985381	.57	.421440	8.53	.578560	13
48	.407299	7.97	.985347	.55	.421952	8.52	.578048	12
49	.407777	7.95	.985314	.57	.422463	8.52	.577537	11
50	9.408254	7.95	9.985280	.55	9.422974	8.50	0.577026	10
51	.408731	7.93	.985247	.57	.423484	8.48	.576516	9
52	.409207	7.92	.985213	.55	.423993	8.50	.576007	8
53	.409682	7.92	.985180	.57	.424503	8.47	.575497	7
54	.410157	7.92	.985146	.55	.425011	8.47	.574989	6
55	9.410632	7.90	9.985113	57	9.425519	8.47	0.574481	5
56	.411106	7.88	.985079	.57	.426027	8.45	.573973	4
57	.411579	7.88	.985045	.57	.426534	8.45	.573466	3
58	.412052	7.87	.985011	.55	.427041	8.43	.572959	2
59	.412524	7.87	.984978	.57	.427547	8.42	.572453	1
60	9.412996		9.984944		9.428052		0.571948	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.[illegible]96	7.85	9.984944	.57	9.428052	8.43	0.571948	60
1	[illegible]67	7.85	.984910	.57	.428558	8.40	.571442	59
2	[illegible]38	7.83	.984876	.57	.429062	8.40	.570938	58
3	[illegible]08	7.83	.984842	.57	.429566	8.40	.570434	57
4	[illegible]78	7.82	.984808	.57	.430070	8.38	.569930	56
5	9.[illegible]47	7.80	9.984774	.57	9.430573	8.37	0.569427	55
6	[illegible]15	7.80	.984740	.57	.431075	8.37	.568925	54
7	[illegible]83	7.80	.984706	.57	.431577	8.37	.568423	53
8	[illegible]51	7.77	.984672	.57	.432079	8.35	.567921	52
9	[illegible]17	7.78	.984638	.58	.432580	8.33	.567420	51
10	9.417684	7.77	9.984603	.57	9.433080	8.33	0.566920	50
11	.418150	7.75	.984569	.57	.433580	8.33	.566420	49
12	.418615	7.73	.984535	.58	.434080	8.32	.565920	48
13	.419079	7.75	.984500	.57	.434579	8.32	.565421	47
14	.419544	7.72	.984466	.57	.435078	8.30	.564922	46
15	9.420007	7.72	9.984432	.58	9.435576	8.28	0.564424	45
16	.420470	7.72	.984397	.57	.436073	8.28	.563927	44
17	.420933	7.70	.984363	.58	.436570	8.28	.563430	43
18	.421395	7.70	.984328	.57	.437067	8.27	.562933	42
19	.421857	7.68	.984294	.58	.437563	8.27	.562437	41
20	9.422318	7.67	9.984259	.58	9.438059	8.25	0.561941	40
21	.422778	7.67	.984224	.57	.438554	8.23	.561446	39
22	.423238	7.65	.934190	.58	.439048	8.25	.560952	38
23	.423697	7.65	.984155	.58	.439543	8.22	.560457	37
24	.424156	7.65	.984120	.58	.440036	8.22	.559964	36
25	9.424615	7.63	9.984085	.58	9.440529	8.22	0.559471	35
26	.425073	7.62	.984050	.58	.441022	8.20	.558978	34
27	.425530	7.62	.984015	.57	.441514	8.20	.558486	33
28	.425987	7.60	.983981	.58	.442006	8.18	.557994	32
29	.426443	7.60	.983946	.58	.442497	8.18	.557503	31
30	9.426899	7.58	9.983911	.60	9.442988	8.18	0.557012	30
31	.427354	7.58	.983875	.58	.443479	8.15	.556521	29
32	.427809	7.57	.983840	.58	.443968	8.17	.556032	28
33	.428263	7.57	.983805	.58	.444458	8.15	.555542	27
34	.428717	7.55	.983770	.58	.444947	8.13	.555053	26
35	9.429170	7.55	9.983735	.58	9.445435	8.13	0.554565	25
36	.429623	7.53	.983700	.60	.445923	8.13	.554077	24
37	.430075	7.53	.983664	.58	.446411	8.12	.553589	23
38	.430527	7.52	.983629	.58	.446898	8.10	.553102	22
39	.430978	7.52	.983594	.60	.447384	8.10	.552616	21
40	9.431429	7.50	9.983558	.58	9.447870	8.10	0.552130	20
41	.431879	7.50	.983523	.60	.448356	8.08	.551644	19
42	.432329	7.48	.983487	.58	.448841	8.08	.551159	18
43	.432778	7.47	.983452	.60	.449326	8.07	.550674	17
44	.433226	7.48	.983416	.58	.449810	8.07	.550190	16
45	9.433675	7.45	9.983381	.60	9.450294	8.05	0.549706	15
46	.434122	7.45	.983345	.60	.450777	8.05	.549223	14
47	.434569	7.45	.983309	.60	.451260	8.05	.548740	13
48	.435016	7.43	.983273	.58	.451743	8.03	.548257	12
49	.435462	7.43	.983238	.60	.452225	8.02	.547775	11
50	9.435908	7.42	9.983202	.60	9.452706	8.02	0.547294	10
51	.436353	7.42	.983166	.60	.453187	8.02	.546813	9
52	.436798	7.40	.983130	.60	.453668	8.00	.546332	8
53	.437242	7.40	.983094	.60	.454148	8.00	.545852	7
54	.437686	7.38	.983058	.60	.454628	7.98	.545372	6
55	9.438129	7.38	9.983022	.60	9.455107	7.98	0.544893	5
56	.438572	7.37	.982986	.60	.455586	7.97	.544414	4
57	.439014	7.37	.982950	.60	.456064	7.97	.543936	3
58	.439456	7.35	.982914	.60	.456542	7.95	.543458	2
59	.439897	7.35	.982878	.60	.457019	7.95	.542981	1
60	9.440338		9.982842		9.457496		0.542504	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.440338	7.33	9.982842	.62	9. 96	7.95	0.542504	60
1	.440778	7.33	.982805	.60	. 73	7.93	.542027	59
2	.441218	7.33	.982769	.60	. 49	7.93	.541551	58
3	.441658	7.30	.982733	.62	. 25	7.92	.541075	57
4	.442096	7.32	.982696	.60	. 00	7.92	.540600	56
5	9.442535	7.30	9.982660	.60	9. 75	7.90	0.540125	55
6	.442973	7.28	.982624	.62	. 49	7.90	.539651	54
7	.443410	7.28	.982587	.60	. 23	7.90	.539177	53
8	.443847	7.28	.982551	.62	. 97	7.88	.538703	52
9	.444284	7.27	.982514	.62	. 70	7.87	.538230	51
10	9.444720	7.25	9.982477	.60	9. 42	7.88	0.537758	50
11	.445155	7.25	.982441	.62	. 15	7.85	.537285	49
12	.445590	7.25	.982404	.62	. 86	7.87	.536814	48
13	.446025	7.23	.982367	.60	. 58	7.83	.536342	47
14	.446459	7.23	.982331	.62	. 28	7.85	.535872	46
15	9.446893	7.22	9.982294	.62	9. 99	7.83	0.535401	45
16	.447326	7.22	.982257	.62	. 69	7.83	.534931	44
17	.447759	7.20	.982220	.62	. 39	7.82	.534461	43
18	.448191	7.20	.982183	.62	. 08	7.82	.533992	42
19	.448623	7.18	.982146	.62	. 77	7.80	.533523	41
20	9.449054	7.18	9.982109	.62	9.466945	7.80	0.533055	40
21	.449485	7.17	.982072	.62	.467413	7.78	.532587	39
22	.449915	7.17	.982035	.62	.467880	7.78	.532120	38
23	.450345	7.17	.981998	.62	.468347	7.78	.531653	37
24	.450775	7.15	.981961	.62	.468814	7.77	.531186	36
25	9.451204	7.13	9.981924	.63	9.469280	7.77	0.530720	35
26	.451632	7.13	.981886	.62	.469746	7.75	.530254	34
27	.452060	7.13	.981849	.62	.470211	7.75	.529789	33
28	.452488	7.12	.981812	.63	.470676	7.75	.529324	32
29	.452915	7.12	.981774	.62	.471141	7.73	.528859	31
30	9.453342	7.10	9.981737	.62	9.471605	7.73	0.528395	30
31	.453768	7.10	.981700	.63	.472069	7.72	.527931	29
32	.454194	7.08	.981662	.62	.472532	7.72	.527468	28
33	.454619	7.08	.981625	.63	.472995	7.70	.527005	27
34	.455044	7.08	.981587	.63	.473457	7.70	.526543	26
35	9.455469	7.07	9.981549	.62	9.473919	7.70	0.526081	25
36	.455893	7.05	.981512	.63	.474381	7.68	.525619	24
37	.456316	7.05	.981474	.63	.474842	7.68	.525158	23
38	.456739	7.05	.981436	.62	.475303	7.67	.524697	22
39	.457162	7.03	.981399	.63	.475763	7.67	.524237	21
40	9.457584	7.03	9.981361	.63	9.476223	7.67	0.523777	20
41	.458006	7.02	.981323	.63	.476683	7.65	.523317	19
42	.458427	7.02	.981285	.63	.477142	7.65	.522858	18
43	.458848	7.00	.981247	.63	.477601	7.63	.522399	17
44	.459268	7.00	.981209	.63	.478059	7.63	.521941	16
45	9.459688	7.00	9.981171	.63	9.478517	7.63	0.521483	15
46	.460108	6.98	.981133	.63	.478975	7.62	.521025	14
47	.460527	6.98	.981095	.63	.479432	7.62	.520568	13
48	.460946	6.97	.981057	.63	.479889	7.60	.520111	12
49	.461364	6.97	.981019	.63	.480345	7.60	.519655	11
50	9.461782	6.95	9.980981	.65	9.480801	7.60	0.519199	10
51	.462199	6.95	.980942	.63	.481257	7.58	.518743	9
52	.462616	6.93	.980904	.63	.481712	7.58	.518288	8
53	.463032	6.93	.980866	.65	.482167	7.57	.517833	7
54	.463448	6.93	.980827	.63	.482621	7.57	.517379	6
55	9.463864	6.92	9.980789	.65	9.483075	7.57	0.516925	5
56	.464279	6.92	.980750	.63	.483529	7.55	.516471	4
57	.464694	6.90	.980712	.65	.483982	7.55	.516018	3
58	.465108	6.90	.980673	.63	.484435	7.53	.515565	2
59	.465522	6.88	.980635	.65	.484887	7.53	.515113	1
60	9.465935		9.980596		9.485339		0.514661	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9. 35	6.88	9.980596	.63	9. 39	7.53	0.514661	60
1	. 48	6.88	.980558	.65	. 91	7.52	.514209	59
2	. 61	6.87	.980519	.65	. 42	7.52	.513758	58
3	. 73	6.87	.980480	.63	. 93	7.50	.513307	57
4	. 85	6.85	.980442	.65	. 43	7.50	.512857	56
5	9. 96	6.85	9.980403	.65	9. 93	7.50	0.512407	55
6	. 07	6.83	.980364	.65	. 43	7.48	.511957	54
7	. 17	6.83	.980325	.65	. 92	7.48	.511508	53
8	. 27	6.83	.980286	.65	. 41	7.48	.511059	52
9	. 37	6.82	.980247	.65	. 90	7.47	.510610	51
10	9.470046	6.82	9.980208	.65	9.489838	7.47	0.510162	50
11	.470455	6.80	.980169	.65	.490286	7.45	.509714	49
12	.470863	6.80	.980130	.65	.490733	7.45	.509267	48
13	.471271	6.80	.980091	.65	.491180	7.45	.508820	47
14	.471679	6.78	.980052	.67	.491627	7.43	.508373	46
15	9.472086	6.77	9.980012	.65	9.492073	7.43	0.507927	45
16	.472492	6.77	.979973	.65	.492519	7.43	.507481	44
17	.472898	6.77	.979934	.65	.492965	7.42	.507035	[illegible]
18	.473304	6.77	.979895	.67	.493410	7.40	.506590	42
19	.473710	6.75	.979855	.65	.493854	7.42	.506146	41
20	9.474115	6.73	9.979816	.67	9.494299	7.40	0.505701	40
21	.474519	6.73	.979776	.65	.494743	7.38	.505257	39
22	.474923	6.73	.979737	.67	.495186	7.40	.504814	38
23	.475327	6.72	.979697	.65	.495630	7.38	.504370	37
24	.475730	6.72	.979658	.67	.496073	7.37	.503927	36
25	9.476133	6.72	9.979618	.65	9.496515	7.37	0.503485	35
26	.476536	6.70	.979579	.67	.496957	7.37	.503043	34
27	.476938	6.70	.979539	.67	.497399	7.37	.502601	33
28	.477340	6.68	.979499	.67	.497841	7.35	.502159	32
29	.477741	6.68	.979459	.65	.498282	7.33	.501718	31
30	9.478142	6.67	9.979420	.67	9.498722	7.35	0.501278	30
31	.478542	6.67	.979380	.67	.499163	7.33	.500837	29
32	.478942	6.67	.979340	.67	.499603	7.32	.500397	28
33	.479342	6.65	.979300	.67	.500042	7.32	.499958	27
34	.479741	6.65	.979260	.67	.500481	7.32	.499519	26
35	9.480140	6.65	9.979220	.67	9.500920	7.32	0.499080	25
36	.480539	6.63	.979180	.67	.501359	7.30	.498641	24
37	.480937	6.62	.979140	.67	.501797	7.30	.498203	23
38	.481334	6.62	.979100	.68	.502235	7.28	.497765	22
39	.481731	6.62	.979059	.67	.502672	7.28	.497328	21
40	9.482128	6.62	19	.67	9.503109	7.28	0.496891	20
41	.482525	6.60	79	.67	.503546	7.27	.496454	19
42	.482921	6.58	39	.68	.503982	7.27	.496018	18
43	.483316	6.60	98	.67	.504418	7.27	.495582	17
44	.483712	6.58	58	.68	.504854	7.25	.495146	16
45	9.484107	6.57	17	.67	9.505289	7.25	0.494711	15
46	.484501	6.57	77	.67	.505724	7.25	.494276	14
47	.484895	6.57	37	.68	.506159	7.23	.493841	13
48	.485289	6.55	96	.68	.506593	7.23	.493407	12
49	.485682	6.55	55	.67	.507027	7.22	.492973	11
50	9. 75	6.53	9.978615	.68	9.507460	7.22	0.492540	10
51	. 77	6.55	.978574	.68	.507893	7.22	.492107	9
52	. 50	6.52	.978533	.67	.508326	7.22	.491674	8
53	. 51	6.53	.978493	.68	.508759	7.20	.491241	7
54	. 43	6.52	.978452	.68	.509191	7.18	.490809	6
55	9. 34	6.50	9.978411	.68	9.509622	7.20	0.490378	5
56	. 24	6.50	.978370	.68	.510054	7.18	.489946	4
57	. 14	6.50	.978329	.68	.510485	7.18	.489515	3
58	. 04	6.48	.978288	.68	.510916	7.17	.489084	2
59	. 93	6.48	.978247	.68	.511346	7.17	.488654	1
60	9. 82		9.978206		9.511776		0.488224	0
	Cos.	D. 1″	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.489982	6.48	9.978206	.68	9.511776	7.17	0.488224	60
1	490371	6.47	.978165	.68	.512206	7.15	.487794	59
2	.490759'	6.47	.978124	.68	.512635	7.15	.487365	58
3	.491147	6.47	.978083	68	.513064	7.15	.486936	57
4	.491535	6.45	.978042	.68	.513493	7.13	.486507	56
5	9.491922	6.43	9.978001	.70	9.513921	7.13	0.486079	55
6	.492308	6.45	.977959	.68	.514349	7.13	.485651	54
7	.492695	6.43	.977918	.68	.514777	7.12	.485223	53
8	.493081	6.42	977877	.70	.515204	7.12	.484796	52
9	.493466	6.42	.977835	.68	.515631	7.10	.484369	51
10	9.493851	6.42	9.977794	.70	9.516057	7.12	0.483943	50
11	.494236	6.42	.977752	.68	.516484	7.10	.483516	49
12	.494621	6.40	.977711	.70	.516910	7.08	.483090	48
13	.495005	6.38	.977669	.68	.517335	7.10	.482665	47
14	.495388	6.40	.977628	.70	517761	7.08	.482239	46
15	9.495772	6.37	9.977586	.70	9.518186	7.07	0.481814	45
16	.496154	6.38	.977544	68	.518610	7.07	.481390	44
17	.496537	6.37	.977503	.70	.519034	7.07	.480966	43
18	.496919	6.37	.977461	.70	.519458	7.07	.480542	42
19	.497301	6.35	.977419	.70	.519882	7.05	.480118	41
20	9.497682	6.37	9.977377	.70	9.520305	7.05	0.479695	40
21	.498064	6.33	.977335	.70	.520728	7.05	.479272	39
22	.498444	6.35	.977293	.70	.521151	7.03	.478849	38
23	.498825	6.32	.977251	.70	.521573	7.03	.478427	37
24	.499204	6.33	.977209	.70	.521995	7.03	.478005	36
25	9.499584	6.32	9.977167	.70	9.522417	7.02	0.477583	35
26	.499963	6.32	.977125	.70	.522838	7.02	.477162	34
27	.500342	6.32	.977083	.70	.523259	7.02	.476741	33
28	.500721	6.30	.977041	.70	.523680	7.00	.476320	32
29	.501099	6.28	.976999	.70	.524100	7.00	.475900	31
30	9.501476	6.30	9.976957	.72	9.524520	7.00	0.475480	30
31	.501854	6.28	.976914	.70	.524940	6.98	.475060	29
32	.502231	6.27	.976872	.70	.525359	6.98	.474641	28
33	.502607	6.28	.976830	.72	.525778	6.98	.474222	27
34	.502984	6.27	.976787	.70	.526197	6.97	.473803	26
35	9.503360	6.25	9.976745	.72	9.526615	6.97	0.473385	25
36	.503735	6.25	.976702	.70	.527033	6.97	.472967	24
37	.504110	6.25	.976660	.72	.527451	6.95	.472549	23
38	.504485	6.25	.976617	.72	.527868	6.95	.472132	22
39	.504860	6.23	.976574	.70	.528285	6.95	.471715	21
40	9.505234	6.23	9.976532	.72	9.528702	6.95	0.471298	20
41	.505608	6.22	.976489	.72	.529119	6.93	.470881	19
42	.505981	6.22	.976446	.70	.529535	6.93	.470465	18
43	.506354	6.22	.976404	.72	.529951	6.92	.470049	17
44	.506727	6.20	.976361	.72	.530366	6.92	.469634	16
45	9.507099	6.20	9.976318	.72	9.530781	6.92	0.469219	15
46	.507471	6.20	.976275	.72	.531196	6.92	.468804	14
47	.507843	6.18	.976232	.72	.531611	6.90	.468389	13
48	.508214	6.18	.976189	.72	.532025	6.90	.467975	12
49	.508585	6.18	.976146	.72	.532439	6.90	.467561	11
50	9.508956	6.17	9.976103	.72	9.532853	6.88	147	10
51	.509326	6.17	.976060	.72	.533266	6.88	734	9
52	.509696	6.15	.976017	.72	.533679	6.88	321	8
53	.510065	6.15	.975974	.73	.534092	6.87	908	7
54	.510434	6.15	.975930	.72	.534504	6.87	496	6
55	9.510803	6.15	9.975887	.72	9.534916	6.87	084	5
56	.511172	6.13	.975844	.73	.535328	6.85	672	4
57	.511540	6.12	.975800	.72	.535739	6.85	261	3
58	.511907	6.13	.975757	.72	.536150	6.85	850	2
59	.512275	6.12	.975714	.73	.536561	6.85	439	1
60	9.512642		9.975670		9.536972		028	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.512642	[illegible]	9.975670	[illegible]	9.536972	[illegible]	0.463028	60

M.	Sin.	D. 1".		D. 1".		D. 1".		
0	9.534052	5.78	9.972986	.77	9.561066	6.55	34	60
1	.534399	5.77	.972940	.77	.561459	6.53	41	59
2	. 45	5.78	.972894	.77	.561851	6.55	49	58
3	92	5.77	.972848	.77	.562244	6.53	56	57
4	38	5.75	.972802	.78	.562636	6.53	64	56
5	9. 83	5.77	9.972755	.77	9.563028	6.52	72	55
6	. 29	5.75	.972709	.77	.563419	6.53	81	54
7	. 74	5.73	.972663	.77	.563811	6.52	89	53
8	. 18	5.75	.972617	.78	.564202	6.52	98	52
9	. 63	5.73	.972570	.77	.564593	6.50	07	51
10	9.537507	5.73	9.972524	.77	9.564983	6.50	0.435017	50
11	.537851	5.72	.972478	.78	.565373	6.50	.434627	49
12	.538194	5.73	.972431	.77	.565763	6.50	.434237	48
13	.538538	5.70	.972385	.78	.566153	6.48	.433847	47
14	.538880	5.72	.972338	.78	.566542	6.50	433458	46
15	9.539223	5.70	9.972291	.77	9.566932	6.47	0.433068	45
16	.539565	5.70	.972245	.78	.567320	6.48	.432680	44
17	.539907	5.70	.972198	.78	.567709	6.48	.432291	43
18	.540249	5.68	.972151	.77	.568098	6.47	.431902	42
19	.540590	5.68	.972105	.78	.568486	6.45	.431514	41
20	9.540931	5.68	9.972058	.78	9.568873	6.47	0.431127	40
21	.541272	5.68	.972011	.78	.569261	6.45	.430739	39
22	.541613	5.67	.971964	.78	.569648	6.45	.430352	38
23	.541953	5.67	.971917	.78	.570035	6.45	.429965	37
24	.542293	5.65	.971870	.78	.570422	6.45	.429578	36
25	9.542632	5.65	9.971823	.78	9.570809	6.43	0.429191	35
26	.542971	5.65	.971776	.78	.571195	6.43	.428805	34
27	.543310	5.65	.971729	.78	.571581	6.43	.428419	33
28	.543649	5.63	.971682	.78	.571967	6.42	.428033	32
29	.543987	5.63	.971635	.78	.572352	6.43	.427648	31
30	9.544325	5.63	9.971588	.80	9.572738	6.42	0.427262	30
31	.544663	5.62	.971540	.78	.573123	6.40	.426877	29
32	.545000	5.63	.971493	.78	.573507	6.42	.426493	28
33	.545338	5.60	.971446	.80	.573892	6.40	.426108	27
34	.545674	5.62	.971398	.78	.574276	6.40	.425724	26
35	9.546011	5.60	9.971351	.80	9.574660	6.40	0.425340	25
36	546347	5.60	.971303	.78	.575044	6.38	.424956	24
37	.546683	5.60	.971256	.80	.575427	6.38	.424573	23
38	.547019	5.58	.971208	.78	.575810	6.38	.424190	22
39	.547354	5.58	.971161	.80	.576193	6.38	.423807	21
40	9. 89	5.58	9.971113	.78	9.576576	6.38	0.423424	20
41	. 24	5.58	.971066	.80	.576959	6.37	.423041	19
42	. 59	5.57	.971018	.80	.577341	6.37	.422659	18
43	. 93	5.57	.970970	.80	.577723	6.35	.422277	17
44	. 27	5.55	.970922	.80	.578104	6.37	.421896	16
45	9. 60	5.55	9.970874	.78	9.578486	6.35	0.421514	15
46	. 93	5.55	.970827	.80	.578867	6.35	.421133	14
47	. 26	5.55	.970779	.80	.579248	6.35	.420752	13
48	.550359	5.55	.970731	.80	.579629	6.33	.420371	12
49	.550692	5.53	.970683	.80	.580009	6.33	.419991	11
50	9.551024	5.53	9.970635	.82	9.580389	6.33	11	10
51	.551356	5.52	.970586	.80	.580769	6.33	31	9
52	.551687	5.52	.970538	.80	.581149	6.32	51	8
53	.552018	5.52	.970490	.80	.581528	6.32	72	7
54	.552349	5.52	.970442	.80	.581907	6.32	93	6
55	9.552680	5.50	9.970394	.82	9.582286	6.32	14	5
56	.553010	5.52	.970345	.80	.582665	6.32	35	4
57	.553341	5.48	.970297	.80	.583044	6.30	56	3
58	.553670	5.50	.970249	.82	.583422	6.30	78	2
59	.554000	5.48	.970200	.80	.583800	6.28	00	1
60	9.554329		9.970152		9.584177		0.415823	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M.

110° 69°

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.554329	5.48	9.970152	.82	9.[illegible]77		0.415823	60
1	.554658	5.48	.970103	.80	.[illegible]55		.415445	59
2	.554987	5.47	.970055	.82	.[illegible]32		.415068	58
3	.555315	5.47	.970006	.82	.[illegible]09		.414691	57
4	.555643	5.47	.969957	.80	.[illegible]86		.414314	56
5	9.555971	5.47	9.969909	.82	9.[illegible]62		0.413938	55
6	.556299	5.45	.969860	.82	.[illegible]39		.413561	54
7	.556626	5.45	.969811	.82	.[illegible]15		.413185	53
8	.556953	5.45	.969762	.80	.[illegible]90		.412810	52
9	.557280	5.43	.969714	.82	.[illegible]66		.412434	51
10	9.557606	5.43	9.969665	.82	9.[illegible]41		0.412059	50
11	.557932	5.43	.969616	.82	.[illegible]16		.411684	49
12	.558258	5.42	.969567	.82	.[illegible]91		.411309	48
13	.558583	5.43	.969518	.82	.[illegible]66		.410934	47
14	.558909	5.42	.969469	.82	.[illegible]40		.410560	46
15	9.559234	5.40	9.969420	.83	9.[illegible]14		0.410186	45
16	.559558	5.42	.969370	.82	.[illegible]88		.409812	44
17	.559883	5.40	.969321	.82	.[illegible]62		.409438	43
18	.560207	5.40	.969272	.82	.590935		.409065	42
19	.560531	5.40	.969223	.83	.591308		.408692	41
20	9.560855	5.38	9.969173	.82	9.591681		0.408319	40
21	.561178	5.38	.969124	.82	.592054		.407946	39
22	.561501	5.38	.969075	.83	.592426		.407574	38
23	.561824	5.37	.969025	.82	.592799		.407201	37
24	.562146	5.37	.968976	.83	.593171		.406829	36
25	9.562468	5.37	9.968926	.82	9.593542		0.406458	35
26	.562790	5.37	.968877	.83	.593914		.406086	34
27	.563112	5.35	.968827	.83	.594285		.405715	33
28	.563433	5.37	.968777	.82	.594656		.405344	32
29	.563755	5.33	.968728	.83	.595027		.404973	31
30	9.564075	5.35	9.968678	.83	9.595398		0.404602	30
31	.564396	5.33	.968628	.83	.595768		.404232	29
32	.564716	5.33	.968578	.83	.596138		.403862	28
33	.565036	5.33	.968528	.82	.596508		.403492	27
34	.565356	5.33	.968479	.83	.596878		.403122	26
35	9.565676	5.32	9.968429	.83	9.597247		0.402753	25
36	.565995	5.32	.968379	.83	.597616		.402384	24
37	.566314	5.30	.968329	.85	.597985		.402015	23
38	.566632	5.32	.968278	.83	.598354		.401646	22
39	.566951	5.30	.968228	.83	.598722		.401278	21
40	9.567269	5.30	9.968178	.83	9.599091		0.400909	20
41	.567587	5.28	.968128	.83	.599459		.400541	[illegible]
42	.567904	5.30	.968078	.85	.599827		.400173	[illegible]
43	.568222	5.28	.968027	.83	.600194		.399806	17
44	.568539	5.28	.967977	.83	.600562		.399438	16
45	9.568856	5.27	9.967927	.85	9.600929		0.399071	15
46	.569172	5.27	.967876	.83	.601296		.398704	14
47	.569488	5.27	.967826	.85	.601663		.398337	13
48	.569804	5.27	.967775	.83	602029		.397971	12
49	.570120	5.25	.967725	.85	.602395		.397605	11
50	9.570435	5.27	9.967674	.83	9.602761		0.397239	10
51	.570751	5.25	.967624	.85	.603127		.396873	9
52	.571066	5.23	.967573	.85	.603493		.396507	8
53	.571380	5.25	.967522	.85	.603858		.396142	7
54	.571695	5.23	.967471	.83	.604223		.395777	6
55	9.572009	5.23	9.967421	.85	9.604588		0.395412	5
56	.572323	5.22	.967370	.85	.604953		.395047	4
57	.572636	5.23	.967319	.85	.605317		.394683	3
58	.572950	5.22	.967268	.85	.605682		.394318	2
59	.573263	5.20	.967217	.85	.606046		.393954	1
60	9.573575		9.967166		9.606410		0.393590	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.573575	5.22	9.967166	.85	9.606410	6.05	0.393590	60
1	.573888	5.20	.967115	.85	.606773	6.07	.393227	59
2	.574200	5.20	.967064	.85	.607137	6.05	.392863	58
3	.574512	5.20	.967013	.87	.607500	6.05	.392500	57
4	.574824	5.20	.966961	.85	.607863	6.03	.392137	56
5	9.575136	5.18	9.966910	.85	9.608225	6.05	0.391775	55
6	.575447	5.18	.966859	.85	.608588	6.03	.391412	54
7	.575758	5.18	.966808	.87	.608950	6.03	.391050	53
8	.576069	5.17	.966756	.85	.609312	6.03	.390688	52
9	.576379	5.17	.966705	.87	.609674	6.03	.390326	51
10	9.576689	5.17	9.966653	.85	9.610036	6.02	0.389964	50
11	.576999	5.17	.966602	.87	.610397	6.03	.389603	49
12	.577309	5.15	.966550	.85	.610759	6.02	.389241	48
13	.577618	5.15	.966499	.87	.611120	6.00	.388880	47
14	.577927	5.15	.966447	.87	.611480	6.02	.388520	46
15	9.578236	5.15	9.966395	.85	9.611841	6.00	0.388159	45
16	.578545	5.13	.966344	.87	.612201	6.00	.387799	44
17	.578853	5.15	.966292	.87	.612561	6.00	.387439	43
18	.579162	5.13	.966240	.87	.612921	6.00	.387079	42
19	.579470	5.12	.966188	.87	.613281	6.00	.386719	41
20	9. 77	5.13	9.966136	.85	9.613641	5.98	0.386359	40
21	. 85	5.12	.966085	.87	.614000	5.98	.386000	39
22	. 92	5.12	.966033	.87	.614359	5.98	.385641	38
23	. 99	5.10	.965981	.87	.614718	5.98	.385282	37
24	. 05	5.12	.965929	.88	.615077	5.97	.384923	36
25	9. 12	5.10	9.965876	.87	9.615435	5.97	0.384565	35
26	. 18	5.10	.965824	.87	.615793	5.97	.384207	34
27	. 24	5.08	.965772	.87	.616151	5.97	.383849	33
28	. 29	5.10	.965720	.87	.616509	5.97	.383491	32
29	. 35	5.08	.965668	.88	.616867	5.95	.383133	31
30	9. 40	5.08	9.965615	.87	9. 24	5.97	0.382776	30
31	. 45	5.07	.965563	.87	. 82	5.95	.382418	29
32	. 49	5.08	.965511	.88	. 39	5.93	.382061	28
33	. 54	5.07	.965458	.87	. 95	5.95	.381705	27
34	. 58	5.05	.965406	.88	. 52	5.93	.381348	26
35	9. 61	5.07	9.965353	.87	9. 08	5.93	0.380992	25
36	. 65	5.05	.965301	.88	. 64	5.93	.380636	24
37	. 68	5.07	.965248	.88	. 20	5.93	.380280	23
38	. 72	5.03	.965195	.87	. 76	5.93	.379924	22
39	. 74	5.05	.965143	.88	. 32	5.92	.379568	21
40	9. 77	5.03	9.965090	.88	9. 87	5.92	0.379213	20
41	. 79	5.05	.965037	.88	. 42	5.92	.378858	19
42	. 82	5.02	.964984	.88	. 97	5.92	.378503	18
43	. 83	5.03	.964931	.87	. 52	5.92	.378148	17
44	. 85	5.02	.964879	.88	. 07	5.90	.377793	16
45	9. 86	5.03	9.964826	.88	9. 61	5.90	0.377439	15
46	88	5.02	.964773	.88	. 15	5.90	.377085	14
47	. 89	5.00	.964720	.90	.[illegible]69	5.90	.376731	13
48	. 89	5.02	.964666	.88	.623623	5.88	.376377	12
49	. 90	5.00	.964613	.88	.623976	5.90	.376024	11
50	9.588890	5.00	9.964560	.88	9. 30	5.88	0.375670	10
51	.589190	4.98	.964507	.88	. 83	5.88	.375317	9
52	.589489	5.00	.964454	.90	. 36	5.87	.374964	8
53	.589789	4.98	.964400	.88	. 88	5.88	.374612	7
54	.590088	4.98	.964347	.88	. 41	5.87	.374259	6
55	9.590387	4.98	9.964294	.90	9. 93	5.87	0.373907	5
56	.590686	4.97	.964240	.88	. 45	5.87	.373555	4
57	.590984	4.97	.964187	.90	. 97	5.87	.373203	3
58	.591282	4.97	.964133	.88	. 49	5.87	.372851	2
59	.591580	4.97	.964080	.90	. 01	5.85	.372499	1
60	9.591878		9.964026		9. 52		0.372148	0
	Cos.	D. 1″.	Sin.	D. 1″	Cot.	D. 1″.	Tan.	M.

Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
9.591878	4.97	9.964026	.90	9.627852	5.85	0.372148	60
.592176	4.95	.963972	.88	.628203	5.85	.371797	59
.592473	4.95	.963919	.90	.628554	5.85	.371446	58
.592770	4.95	.963865	.90	.628905	5.83	.371095	57
.593067	4.93	.963811	.90	.629255	5.85	.370745	56
9.593363	4.93	9.963757	.88	9.629606	5.83	0.370394	55
.593659	4.93	.963704	.90	.629956	5.83	.370044	54
.593955	4.93	.963650	.90	.630306	5.83	.369694	53
.594251	4.93	.963596	.90	.630656	5.82	.369344	52
.594547	4.92	.963542	.90	.631005	5.83	.368995	51
9.594842	4.92	9.963488	.90	9.[illegible]55	5.82	0.368645	50
.595137	4.92	.963434	.92	.[illegible]04	5.82	.368296	49
.595432	4.92	.963379	.90	.[illegible]53	5.82	.367947	48
.595727	4.90	.963325	.90	.[illegible]02	5.80	.367598	47
.596021	4.90	.963271	.90	.[illegible]50	5.82	.367250	46
9.596315	4.90	9.963217	.90	9.[illegible]99	5.80	0.366901	45
.596609	4.90	.963163	.92	.[illegible]47	5.80	.366553	44
.596903	4.88	.963108	.90	.[illegible]95	5.80	.366205	43
.597196	4.90	.963054	.92	.[illegible]43	5.78	.365857	42
.597490	4.88	.962999	.90	.[illegible]90	5.80	.365510	41
9.597783	4.87	9.962945	.92	9.[illegible]38	5.78	0.365162	40
.598075	4.88	.962890	.90	.[illegible]85	5.78	.364815	39
.598368	4.87	.962836	.92	.[illegible]32	5.78	.364468	38
.598660	4.87	.962781	.90	.[illegible]79	5.78	.364121	37
.598952	4.87	.962727	.92	.[illegible]26	5.77	.363774	36
9.599244	4.87	9.962672	.92	9.[illegible]72	5.78	0.363428	35
.599536	4.85	.962617	.92	.[illegible]19	5.77	.363081	34
.599827	4.85	.962562	.90	.[illegible]65	5.77	.362735	33
.600118	4.85	.962508	.92	.[illegible]11	5.75	.362389	32
.600409	4.85	.962453	.92	.[illegible]56	5.77	.362044	31
9.600700	4.83	9.962398	.92	9.[illegible]02	5.75	0.361698	30
.600990	4.83	.962343	.92	.[illegible]47	5.75	.361353	29
.601280	4.83	.962288	.92	.[illegible]92	5.75	.361008	28
.601570	4.83	.962233	.92	.[illegible]37	5.75	.360663	27
.601860	4.83	.962178	.92	.[illegible]82	5.75	.360318	26
9.602150	4.82	9.962123	.93	9.[illegible]27	5.73	0.359973	25
.602439	4.82	.962067	.92	.[illegible]71	5.75	.359629	24
.602728	4.82	.962012	.92	.[illegible]16	5.73	.359284	23
.603017	4.80	.961957	.92	.[illegible]60	5.73	.358940	22
.603305	4.82	.961902	.93	.641404	5.72	.358596	21
9.603594	4.80	9.961846	.92	9.641747	5.73	0.358253	20
.603882	4.80	.961791	.93	.642091	5.72	.357909	19
.604170	4.78	.961735	.92	.642434	5.72	.357566	18
.604457	4.80	.961680	.93	.642777	5.72	.357223	17
.604745	4.78	.961624	.92	.643120	5.72	.356880	16
9.605032	4.78	9.961569	.93	9.643463	5.72	0.356537	15
.605319	4.78	.961513	.92	.643806	5.70	.356194	14
.605606	4.77	.961458	.93	.644148	5.70	.355852	13
.605892	4.78	.961402	.93	.644490	5.70	.355510	12
.606179	4.77	.961346	.93	.644832	5.70	.355168	11
9.606465	4.77	9.961290	92	9.[illegible]174	5.70	0.354826	10
.606751	4.75	.961235	.93	[illegible]516	5.68	.354484	9
.607036	4.77	.961179	93	[illegible]57	5.70	.354143	8
.607322	4.75	.961123	.93	[illegible]199	5.68	.353801	7
.607607	4.75	.961067	.93	[illegible]40	5.68	.353460	6
9.607892	4.75	9.961011	.93	9.[illegible]81	5.68	0.353119	5
.608177	4.73	.960955	.93	[illegible]222	5.67	.352778	4
.608461	4.73	.960899	.93	[illegible]562	5.68	.352438	3
.608745	4.73	.960843	.93	[illegible]903	5.67	.352097	2
.609029	4.73	.960786	.95	[illegible]243	5.67	.351757	1
9.609313		9.960730		9.[illegible]583		0.351417	0
Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.609313	4.73	9.960730	.93	9.648583	5.67	0.351417	60
1	.609597	4.72	.960674	.93	.648923	5.67	.351077	59
2	.609880	4.73	.960618	.95	.649263	5.65	.350737	58
3	.610164	4.72	.960561	.93	.649602	5.67	.350398	57
4	.610447	4.70	.960505	.95	.649942	5.65	.350058	56
5	9.610729	4.72	9.960448	.93	9.650281	5.65	0.349719	55
6	.611012	4.70	.960392	.95	.650620	5.65	.349380	54
7	.611294	4.70	.960335	.93	.650959	5.63	.349041	53
8	.611576	4.70	.960279	.95	.651297	5.65	.348703	52
9	.611858	4.70	.960222	.95	.651636	5.63	.348364	51
10	9.612140	4.68	9.960165	.93	9.[illegible]74	5.63	0.348026	50
11	.6[illegible]21	4.68	.960109	.95	.[illegible]12	5.63	[illegible]88	49
12	.6[illegible]02	4.68	.960052	.95	.[illegible]50	5.63	[illegible]50	48
13	.6[illegible]83	4.68	.959995	.95	.[illegible]88	5.63	[illegible]12	47
14	.6[illegible]64	4.68	.959938	.93	.[illegible]26	5.62	[illegible]74	46
15	9.6[illegible]45	4.67	9.959882	.95	9.[illegible]63	5.62	[illegible]37	45
16	.6[illegible]25	4.67	.959825	.95	.[illegible]00	5.62	[illegible]00	44
17	.6[illegible]05	4.67	.959768	.95	.[illegible]37	5.62	[illegible]63	43
18	.6[illegible]85	4.67	.959711	.95	.[illegible]74	5.62	[illegible]26	42
19	.6[illegible]65	4.65	.959654	.97	.[illegible]11	5.62	[illegible]89	41
20	9.614944	4.65	9.959596	.95	9.[illegible]48	5.60	0.344652	40
21	.615223	4.65	.959539	.95	.[illegible]84	5.60	.344316	39
22	.615502	4.65	.959482	.95	.[illegible]20	5.60	.343980	38
23	.615781	4.65	.959425	.95	.[illegible]56	5.60	.343644	37
24	.616060	4.63	.959368	.97	.[illegible]92	5.60	.343308	36
25	9.616338	4.63	9.959310	.95	9.[illegible]28	5.60	0.342972	35
26	.616616	4.63	.959253	.97	.[illegible]64	5.58	.342636	34
27	.616894	4.63	.959195	.95	.[illegible]99	5.58	.342301	33
28	.617172	4.63	.959138	.97	.[illegible]34	5.58	.341966	32
29	.617450	4.62	.959080	.95	.[illegible]69	5.58	.341631	31
30	9.[illegible]27	4.62	9.9[illegible]23	.97	9.[illegible]04	5.58	0[illegible]96	30
31	.[illegible]04	4.62	.9[illegible]65	.95	.[illegible]39	5.57	[illegible]61	29
32	.[illegible]81	4.62	.9[illegible]08	.97	.[illegible]73	5.58	[illegible]27	28
33	.[illegible]58	4.60	.9[illegible]50	.97	.[illegible]08	5.57	[illegible]92	27
34	.[illegible]34	4.60	.9[illegible]92	.97	.[illegible]42	5.57	[illegible]58	26
35	9.[illegible]10	4.60	9.9[illegible]34	.95	9.[illegible]76	5.57	0[illegible]24	25
36	.[illegible]86	4.60	.9[illegible]77	.97	.[illegible]10	5.55	[illegible]90	24
37	.[illegible]62	4.60	.9[illegible]19	.97	.661043	5.57	[illegible]57	23
38	.619938	4.58	.9[illegible]61	.97	.661377	5.55	[illegible]23	22
39	.620213	4.58	.9[illegible]03	.97	.661710	5.55	[illegible]90	21
40	9.620488	4.58	9.958445	.97	9.[illegible]43	5.55	0.337957	20
41	.620763	4.58	.958387	.97	.[illegible]76	5.55	.337624	19
42	.621038	4.58	.958329	.97	.[illegible]09	5.55	.337291	18
43	.621313	4.57	.958271	.97	.[illegible]42	5.55	.336958	17
44	.621587	4.57	.958213	.98	.[illegible]75	5.53	.336625	16
45	9.621861	4.57	9.958154	.97	9.[illegible]07	5.53	0.336293	15
46	.622135	4.57	.958096	.97	.[illegible]39	5.53	.335961	14
47	.622409	4.55	.958038	.98	.[illegible]71	5.53	.335629	13
48	.622682	4.57	.957979	.97	.[illegible]03	5.53	.335297	12
49	.622956	4.55	.957921	.97	.665035	5.52	.334965	11
50	9.623229	4.55	9.957863	.98	[illegible]66	5.53	0.334634	10
51	.623502	4.53	.957804	.97	[illegible]98	5.52	.334302	9
52	.623774	4.55	.957746	.98	[illegible]29	5.52	.333971	8
53	.624047	4.53	.957687	.98	[illegible]60	5.52	.333640	7
54	.624319	4.53	.957628	.97	[illegible]91	5.50	.333309	6
55	9.624591	4.53	9.957570	.98	[illegible]21	5.52	0.332979	5
56	.624863	4.53	.957511	.98	[illegible]52	5.50	.332648	4
57	.625135	4.52	.957452	.98	[illegible]82	5.52	.332318	3
58	.625406	4.52	.957393	.97	[illegible]13	5.50	.331987	2
59	.625677	4.52	.957335	.98	[illegible]43	5.50	.331657	1
60	9.625948		9.957276		[illegible]73		0.331327	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
9.625948	4.52	9.957276	.98	9. 73	5.48	0.331327	60
.626219	4.52	.957217	.98	. 02	5.50	.330998	59
.626490	4.50	.957158	.98	. 32	5.48	.330668	58
.626760	4.50	.957099	.98	. 61	5.50	.330339	57
.627030	4.50	.957040	.98	. 91	5.48	.330009	56
9.627300	4.50	9.956981	1.00	9. 20	5.48	0.329680	55
.627570	4.50	.956921	.98	. 49	5.47	.329351	54
.627840	4.48	.956862	.98	. 77	5.48	.329023	53
.628109	4.48	.956803	.98	. 06	5.48	.328694	52
.628378	4.48	.956744	1.00	. 35	5.47	.328365	51
9.628647	4.48	84	.98	9. 63	5.47	0.328037	50
.628916	4.48	25	.98	. 91	5.47	.327709	49
.629185	4.47	66	1.00	. 19	5.47	.327381	48
.629453	4.47	06	.98	. 47	5.45	.327053	47
.629721	4.47	47	1.00	. 74	5.47	.326726	46
9.629989	4.47	87	1.00	9. 02	5.45	0.326398	45
.630257	4.45	27	.98	. 29	5.47	.326071	44
.630524	4.47	68	1.00	. 57	5.45	.325743	43
.630792	4.45	08	1.00	. 84	5.45	.325416	42
.631059	4.45	48	.98	. 11	5.43	.325089	41
9.631326	4.45	9.956089	1.00	9. 37	5.45	0.324763	40
.631593	4.43	.956029	1.00	. 64	5.43	.324436	39
.631859	4.43	.955969	1.00	. 90	5.45	.324110	38
.632125	4.45	.955909	1.00	. 17	5.43	.323783	37
.632392	4.43	.955849	1.00	. 43	5.43	.323457	36
9.632658	4.42	9.955789	1.00	9. 69	5.42	0.323131	35
.632923	4.43	.955729	1.00	. 94	5.43	.322806	34
.633189	4.42	.955669	1.00	. 20	5.43	.322480	33
.633454	4.42	.955609	1.02	. 46	5.42	.322154	32
.633719	4.42	.955548	1.00	. 71	5.42	.321829	31
9.633984	4.42	9.955488	1.00	9.678496	5.42	0.321504	30
.634249	4.42	.955428	1.00	.678821	5.42	179	29
.634514	4.40	.955368	1.02	.679146	5.42	54	28
.634778	4.40	.955307	1.00	.679471	5.40	29	27
.635042	4.40	.955247	1.02	.679795	5.42	05	26
9.635306	4.40	9.955186	1.00	9.680120	5.40	80	25
.635570	4.40	.955126	1.02	.680444	5.40	56	24
.635834	4.38	.955065	1.00	.680768	5.40	32	23
.636097	4.38	.955005	1.02	.681092	5.40	08	22
.636360	4.38	.954944	1.02	.681416	5.40	84	21
9.636623	4.38	9.954883	1.00	9. 40	5.38	0.318260	20
.636886	4.37	.954823	1.02	. 63	5.40	.317937	19
.637148	4.38	.954762	1.02	. 87	5.38	.317613	18
.637411	4.37	.954701	1.02	. 10	5.38	.317290	17
.637673	4.37	.954640	1.02	. 33	5.38	.316967	16
9.637935	4.37	9.954579	1.02	9. 56	5.38	0.316644	15
.638197	4.35	.954518	1.02	. 79	5.37	.316321	14
.638458	4.37	.954457	1.02	. 01	5.38	.315999	13
.638720	4.35	.954396	1.02	. 24	5.37	.315676	12
.638981	4.35	.954335	1.02	. 46	5.37	.315354	11
9.639242	4.35	9.954274	1.02	9. 68	5.37	0.315032	10
.639503	4.35	.954213	1.02	. 90	5.37	.314710	9
.639764	4.33	.954152	1.03	. 12	5.37	.314388	8
.640024	4.33	.954090	1.02	. 34	5.35	.314066	7
.640284	4.33	.954029	1.02	. 55	5.37	.313745	6
9.640544	4.33	9.953968	1.03	9. 77	5.35	0.313423	5
.640804	4.33	.953906	1.02	. 98	5.35	.313102	4
.641064	4.33	.953845	1.03	. 19	5.35	.312781	3
.641324	4.32	.953783	1.02	. 40	5.35	.312460	2
.641583	4.32	.953722	1.03	. 61	5.35	.312139	1
9.641842		9.953660		9. 82		0.311818	0
Cos.	D. 1″.	Sin.	D. 1″	Cot.	D. 1″.	Tan.	M

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.641842	4.32	9.953660	1.02	9.688182	5.33	0.311818	60
1	.642101	4.32	.953599	1.03	. 02	5.35	.311498	59
2	.642360	4.30	.953537	1.03	. 23	5.33	311177	58
3	.642618	4.32	.953475	1.03	. 43	5.33	.310857	57
4	.642877	4.30	.953413	1.02	. 63	5.33	.310537	56
5	9.643135	4.30	9.953352	1.03	9. 83	5.33	0.310217	55
6	.643393	4.28	.953290	1.03	. 03	5.33	.309897	54
7	.643650	4.30	.953228	1.03	. 23	5.32	.309577	53
8	.643908	4.28	.953166	1.03	. 42	5.33	.309258	52
9	.644165	4.30	.953104	1.03	. 62	5.32	.308938	51
10	9. 23	4.28	9.953042	1.03	9. 81	5.32	0.308619	50
11	. 80	4.27	.952980	1.03	. 00	5.32	.308300	49
12	. 36	4.28	.952918	1.05	. 19	5.32	.307981	48
13	. 93	4.28	.952855	1.03	. 38	5.30	.307662	47
14	. 50	4.27	.952793	1.03	. 56	5.32	.307344	46
15	9. 06	4.27	9.952731	1.03	9. 75	5.30	0.307025	45
16	. 62	4.27	.952669	1.05	. 93	5.32	.306707	44
17	. 18	4.27	.952606	1.03	. 12	5.30	.306388	43
18	. 74	4.25	.952544	1.05	. 30	5.30	.306070	42
19	. 29	4.25	.952481	1.03	. 48	5.30	.305752	41
20	9. 84	4.27	9.952419	1.05	9.694566	5.28	0.305434	40
21	. 40	4.23	.952356	1.03	.694883	5.30	.305117	39
22	. 94	4.25	.952294	1.05	.695201	5.28	.304799	38
23	. 49	4.25	.952231	1.05	.695518	5.30	.304482	37
24	. 04	4.23	.952168	1.03	.695836	5.28	.304164	36
25	9. 58	4.23	9.952106	1.05	9.696153	5.28	0.303847	35
26	. 12	4.23	.952043	1.05	.696470	5.28	.303530	34
27	. 66	4.23	.951980	1.05	.696787	5.27	.303213	33
28	. 20	4.23	.951917	1.05	.697103	5.28	.302897	32
29	. 74	4.22	.951854	1.05	.697420	5.27	.302580	31
30	9. 27	4.23	9.951791	1.05	9.697736	5.28	0.302264	30
31	. 81	4.22	.951728	1.05	.698053	5.27	.301947	29
32	. 34	4.22	.951665	1.05	.698369	5.27	.301631	28
33	. 87	4.20	.951602	1.05	.698685	5.27	.301315	27
34	. 39	4.22	.951539	1.05	.699001	5.25	.300999	26
35	9. 92	4.20	9.951476	1.07	9.699316	5.27	0.300684	25
36	. 44	4.22	.951412	1.05	.699632	5.25	.300368	24
37	. 97	4.20	.951349	1.05	.699947	5.27	.300053	23
38	. 49	4.18	.951286	1.07	.700263	5.25	.299737	22
39	. 00	4.20	.951222	1.05	.700578	5.25	.299422	21
40	9.652052	4.20	9.951159	1.05	9.700893	5.25	0.299107	20
41	.652304	4.18	.951096	1.07	.701208	5.25	.298792	19
42	.652555	4.18	.951032	1.07	.701523	5.23	.298477	18
43	.652806	4.18	.950968	1.05	.701837	5.25	.298163	17
44	.653057	4.18	.950905	1.07	.702152	5.23	.297848	16
45	9.653308	4.17	9.950841	1.05	9.702466	5.25	0.297534	15
46	.653558	4.17	.950778	1.07	.702781	5.23	.297219	14
47	.653808	4.18	.950714	1.07	.703095	5.23	.296905	13
48	.654059	4.17	.950650	1.07	.703409	5.22	.296591	12
49	.654309	4.15	.950586	1.07	.703722	5.23	.296278	11
50	9. 58	4.17	9.950522	1.07	9.704036	5.23	0.295964	10
51	. 08	4.17	.950458	1.07	.704350	5.22	.295650	9
52	. 58	4.15	.950394	1.07	.704663	5.22	.295337	8
53	. 07	4.15	.950330	1.07	.704976	5.23	.295024	7
54	. 56	4.15	.950266	1.07	.705290	5.22	.294710	6
55	9. 05	4.15	9.950202	1.07	9.705603	5.22	0.294397	5
56	. 54	4.13	.950138	1.07	.705916	5.20	.294084	4
57	. 02	4.15	.950074	1.07	.706228	5.22	.293772	3
58	. 51	4.13	.950010	1.08	.706541	5.22	.293459	2
59	. 99	4.13	.949945	1.07	.706854	5.20	.293146	1
60	9. 47		9.949881		9.707166		0.292834	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M

M	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.657047	4.13	9.949881	1.08	9.707166	5.20	0.292834	60
1	.657295	4.12	.949816	1.07	.707478	5.20	.292522	59
2	.657542	4.13	.949752	1.07	.707790	5.20	.292210	58
3	.657790	4.12	.949688	1.08	.708102	5.20	.291898	57
4	.658037	4.12	.949623	1.08	.708414	5.20	.291586	56
5	9.658284	4.12	9.949558	1.07	9.708726	5.18	0.291274	55
6	.658531	4.12	.949494	1.08	.709037	5.20	.290963	54
7	.658778	4.12	.949429	1.08	.709349	5.18	.290651	53
8	.659025	4.10	.949364	1.07	.709660	5.18	.290340	52
9	.659271	4.10	.949300	1.08	.709971	5.18	.290029	51
10	9.659517	4.10	9.949235	1.08	9.710282	5.18	0.2[illegible]18	50
11	.659763	4.10	.949170	1.08	.710593	5.18	.2[illegible]07	49
12	.660009	4.10	.949105	1.08	.710904	5.18	.2[illegible]96	48
13	.660255	4.10	.949040	1.08	.711215	5.17	.2[illegible]85	47
14	.660501	4.08	.948975	1.08	.711525	5.18	.2[illegible]75	46
15	9.660746	4.08	9.948910	1.08	9.711836	5.17	0.2[illegible]64	45
16	.660991	4.08	.948845	1.08	.712146	5.17	.2[illegible]54	44
17	.661236	4.08	.948780	1.08	.712456	5.17	.2[illegible]44	43
18	.661481	4.08	.948715	1.08	.712766	5.17	.2[illegible]34	42
19	.661726	4.07	.948650	1.10	.713076	5.17	.2[illegible]24	41
20	9.661970	4.07	9.948584	1.08	9.713386	5.17	0.286614	40
21	.662214	4.08	.948519	1.08	.713696	5.15	.286304	39
22	.662459	4.07	.948454	1.10	.714005	5.15	.285995	38
23	.662703	4.05	.948388	1.08	.714314	5.17	.285686	37
24	.662946	4.07	.948323	1.10	.714624	5.15	.285376	36
25	9.663190	4.05	9.948257	1.08	9.714933	5.15	0.285067	35
26	.663433	4.07	.948192	1.10	.715242	5.15	.284758	34
27	.663677	4.05	.948126	1.10	.715551	5.15	.284449	33
28	.663920	4.05	.948060	1.08	.715860	5.13	.284140	32
29	.664163	4.05	.947995	1.10	.716168	5.15	.283832	31
30	9.664406	4.03	9.947929	1.10	9.716477	5.13	0.283523	30
31	.664648	4.05	.947863	1.10	.716785	5.13	.283215	29
32	.664891	4.03	.947797	1.10	.717093	5.13	.282907	28
33	.665133	4.03	.947731	1.10	.717401	5.13	.282599	27
34	.665375	4.03	.947665	1.08	.717709	5.13	.282291	26
35	9.665617	4.03	9.947600	1.12	9.718017	5.13	0.281983	25
36	.665859	4.02	.947533	1.10	.718325	5.13	.281675	24
37	.666100	4.03	.947467	1.10	.718633	5.12	.281367	23
38	.666342	4.02	.947401	1.10	.718940	5.13	.281060	22
39	.666583	4.02	.947335	1.10	.719248	5.12	.280752	21
40	9.666824	4.02	9.947269	1.10	9.719555	5.12	[illegible]45	20
41	.667065	4.00	.947203	1.12	.719862	5.12	[illegible]38	19
42	.667305	4.02	.947136	1.10	.720169	5.12	[illegible]31	18
43	.667546	4.00	.947070	1.10	.720476	5.12	[illegible]24	17
44	.667786	4.02	.947004	1.12	.720783	5.10	[illegible]17	16
45	9.668027	4.00	9.946937	1.10	9.721089	5.12	[illegible]11	15
46	.668267	3.98	.946871	1.12	.721396	5.10	[illegible]04	14
47	.668506	4.00	.946804	1.10	.721702	5.12	[illegible]98	13
48	.668746	4.00	.946738	1.12	.722009	5.10	.277991	12
49	.668986	3.98	.946671	1.12	.722315	5.10	.277685	11
50	9.669225	3.98	9.946604	1.10	9.722621	5.10	0.277379	10
51	.669464	3.98	.946538	1.12	.722927	5.08	.277073	9
52	.669703	3.98	.946471	1.12	.723232	5.10	.276768	8
53	.669942	3.98	.946404	1.12	.723538	5.10	.276462	7
54	.670181	3.97	.946337	1.12	.723844	5.08	.276156	6
55	9.670419	3.98	9.946270	1.12	9.724149	5.08	0.275851	5
56	.670658	3.97	.946203	1.12	.724454	5.10	.275546	4
57	.670896	3.97	.946136	1.12	.724760	5.08	.275240	3
58	.671134	3.97	.946069	1.12	.725065	5.08	.274935	2
59	.671372	3.95	.946002	1.12	.725370	5.07	.274630	1
60	9.671609		9.945935		9.725674		0.274326	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9. 09	3.97	9.945935	1.12	9.725674	5.08	0.274326	60
1	. 47	3.95	.945868	1.13	. 79	5.08	.274021	59
2	. 84	3.95	.945800	1.12	. 84	5.07	.273716	58
3	. 21	3.95	.945733	1.12	. 88	5.07	.273412	57
4	. 58	3.95	.945666	1.13	. 92	5.08	.273108	56
5	9. 95	3.95	9.945598	1.12	9. 97	5.07	0.272803	55
6	. 32	3.93	.945531	1.12	. 01	5.07	.272499	54
7	. 68	3.95	.945464	1.13	. 05	5.07	.272195	53
8	. 05	3.93	.945396	1.13	. 09	5.05	.271891	52
9	. 41	3.93	.945328	1.12	. 12	5.07	.271588	51
10	9. 77	3.93	9.945261	1.13	9.728716	5.07	0. 4	50
11	. 13	3.92	.945193	1.13	.729020	5.05	. 0	49
12	. 48	3.93	.945125	1.12	.729323	5.05	. 7	48
13	. 84	3.92	.945058	1.13	.729626	5.05	. 4	47
14	. 19	3.93	.944990	1.13	.729929	5.07	. 1	46
15	9. 55	3.92	9.944922	1.13	9.730233	5.03	0. 7	45
16	. 90	3.90	.944854	1.13	.730535	5.05	. 5	44
17	. 24	3.92	.944786	1.13	.730838	5.05	. 2	43
18	. 59	3.92	.944718	1.13	.731141	5.05	. 9	42
19	. 94	3.90	.944650	1.13	.731444	5.03	. 6	41
20	9. 28	3.90	9.944582	1.13	9.731746	5.03	0.268254	40
21	. 62	3.90	.944514	1.13	.732048	5.05	.267952	39
22	. 96	3.90	.944446	1.15	.732351	5.03	.267649	38
23	. 30	3.90	.944377	1.13	.732653	5.03	.267347	37
24	. 64	3.90	.944309	1.13	.732955	5.03	.267045	36
25	9. 98	3.88	9.944241	1.15	9.733257	5.02	0.266743	35
26	. 31	3.88	.944172	1.13	.733558	5.03	.266442	34
27	. 64	3.88	.944104	1.13	.733860	5.03	.266140	33
28	. 97	3.88	.944036	1.15	.734162	5.02	.265838	32
29	. 30	3.88	.943967	1.13	.734463	5.02	.265537	31
30	9. 63	3.87	9.943899	1.15	9.734764	5.03	0.265236	30
31	. 95	3.88	.943830	1.15	.735066	5.02	.264934	29
32	. 28	3.87	.943761	1.13	.735367	5.02	.264633	28
33	. 60	3.87	.943693	1.15	.735668	5.02	.264332	27
34	. 92	3.87	.943624	1.15	.735969	5.00	.264031	26
35	9. 24	3.87	9.943555	1.15	9.736269	5.02	0.263731	25
36	. 56	3.87	.943486	1.15	.736570	5.00	.263430	24
37	. 88	3.85	.943417	1.15	.736870	5.02	.263130	23
38	. 19	3.85	.943348	1.15	.737171	5.00	.262829	22
39	. 50	3.87	.943279	1.15	.737471	5.00	.262529	21
40	9.680982	3.85	9.943210	1.15	9.737771	5.00	0.262229	20
41	.681213	3.83	.943141	1.15	.738071	5.00	.261929	19
42	. 43	3.85	.943072	1.15	.738371	5.00	.261629	18
43	. 74	3.85	.943003	1.15	.738671	5.00	.261329	17
44	. 05	3.83	.942934	1.17	.738971	5.00	.261029	16
45	9. 35	3.83	9.942864	1.15	9.739271	4.98	0.260729	15
46	. 65	3.83	.942795	1.15	.739570	5.00	.260430	14
47	95	3.83	.942726	1.17	.739870	4.98	.260130	13
48	. 25	3.83	.942656	1.15	.740169	4.98	.259831	12
49	. 55	3.82	.942587	1.17	.740468	4.98	.259532	11
50	9. 84	3.83	9.942517	1.15	9.740767	4.98	0.259233	10
51	. 14	3.82	.942448	1.17	.741066	4.98	.258934	9
52	. 43	3.82	.942378	1.17	.741365	4.98	.258635	8
53	. 72	3.82	.942308	1.15	.741664	4.97	.258336	7
54	. 01	3.82	.942239	1.17	.741962	4.98	.258038	6
55	9. 30	3.80	9.942169	1.17	9.742261	4.97	0.257739	5
56	. 58	3.82	.942099	1.17	.742559	4.98	.257441	4
57	. 87	3.80	.942029	1.17	.742858	4.97	.257142	3
58	. 15	3.80	.941959	1.17	.743156	4.97	.256844	2
59	. 43	3.80	.941889	1.17	.743454	4.97	.256546	1
60	9. 71		9.941819		9.743752		0.256248	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1".	Cos.	D. 1"
0	9. 71	3.80	9.941819	1.17
1	. 99	3.80	.941749	1.17
2	. 27	3.78	.941679	1.17
3	. 54	3.80	.941609	1.17
4	. 82	3.78	.941539	1.17
5	9. 09	3.78	9.941469	1.18
6	. 36	3.78	.941398	1.17
7	. 63	3.77	.941328	1.17
8	. 89	3.78	.941258	1.18
9	. 16	3.78	.941187	1.17
10	9. 43	3.77	9.941117	1.18
11	. 69	3.77	.941046	1.18
12	. 95	3.77	.940975	1.17
13	. 21	3.77	.940905	1.18
14	. 47	3.75	.940834	1.18
15	9. 72	3.77	9.940763	1.17
16	. 98	3.75	.940693	1.18
17	. 23	3.75	.940622	1.18
18	. 48	3.75	.940551	1.18
19	. 73	3.75	.940480	1.18
20	9. 98	3.75	9.940409	1.18
21	. 23	3.75	.940338	1.18
22	. 48	3.73	.940267	1.18
23	. 72	3.73	.940196	1.18
24	. 96	3.73	.940125	1.18
25	9. 20	3.73	9.940054	1.20
26	. 44	3.73	.939982	1.18
27	. 68	3.73	.939911	1.18
28	. 92	3.72	.939840	1.20
29	. 15	3.73	.939768	1.18
30	9. 39	3.72	9.939697	1.20
31	. 62	3.72	.939625	1.18
32	. 85	3.72	.939554	1.20
33	. 08	3.72	.939482	1.20
34	. 31	3.70	.939410	1.18
35	9. 53	3.72	9.939339	1.20
36	. 76	3.70	.939267	1.20
37	. 98	3.70	.939195	1.20
38	. 20	3.70	.939123	1.18
39	. 42	3.70	.939052	1.20
40	9 64	3.70	80	1.20
41	. 86	3.68	08	1.20
42	. 07	3.70	36	1.22
43	. 29	3.68	63	1.20
44	. 50	3.68	91	1.20
45	9. 71	3.68	19	1.20
46	. 92	3.68	47	1.20
47	. 13	3.68	75	1.22
48	. 34	3.67	02	1.20
49	. 54	3.68	30	1.20
50	9. 75	3.67	9.938258	1.22
51	. 95	3.67	.938185	1.20
52	. 15	3.67	.938113	1.22
53	. 35	3.65	.938040	1.22
54	. 54	3.67	.937967	1.20
55	9. 74	3.67	9.937895	1.22
56	. 94	3.65	.937822	1.22
57	. 13	3.65	.937749	1.22
58	. 32	3.65	.937676	1.20
59	. 51	3.65	.937604	1.22
60	9. 70		9.937531	
	Cos.	D. 1".	Sin.	D. 1"

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.698970	3.65	9.937531	1.22	9.761439	4.87	0.238561	60
1	.699189	3.63	.937458	1.22	.761731	4.87	238269	59
2	.699407	3.65	.937385	1.22	.762023	4.85	.237977	58
3	.699626	3.63	.937312	1.23	.762314	4.87	.237686	57
4	.699844	3.63	.937238	1.22	.762606	4.85	.237394	56
5	9.700062	3.63	9.937165	1.22	9.762897	4.85	0.237103	55
6	.700280	3.63	.937092	1.22	.763188	4.85	.236812	54
7	.700498	3.63	.937019	1.22	.763479	4.85	.236521	53
8	700716	3.62	.936946	1.23	.763770	4.85	.236230	52
9	.700933	3.63	.936872	1.22	.764061	4.85	.235939	51
10	9.701151	3.62	9.936799	1.23	9.764352	4.85	0.235648	50
11	.701368	3.62	.936725	1.22	.764643	4.83	.235357	49
12	.701585	3.62	.936652	1.23	.764933	4.85	.235067	48
13	.701802	3.62	.936578	1.22	.765224	4.83	.234776	47
14	.702019	3.62	.936505	1.23	.765514	4.85	.234486	46
15	9.702236	3.60	9.936431	1.23	9.765805	4.83	0.234195	45
16	.702452	3.62	.936357	1.22	.766095	4.83	.233905	44
17	.702669	3.60	.936284	1.23	.766385	4.83	.233615	43
18	.702885	3.60	.936210	1.23	.766675	4.83	.233325	42
19	.703101	3.60	.936136	1.23	.766965	4.83	.233035	41
20	9.703317	3.60	9.936062	1.23	9.767255	4.83	0.232745	40
21	.703533	3.60	.935988	1.23	.767545	4.82	.232455	39
22	.703749	3.58	.935914	1.23	.767834	4.83	.232166	38
23	.703964	3.58	.935840	1.23	.768124	4.83	.231876	37
24	704179	3.60	.935766	1.23	.768414	4.82	.231586	36
25	9.704395	3.58	9.935692	1.23	9.768703	4.82	0.231297	35
26	704610	3.58	.935618	1.25	.768992	4.82	.231008	34
27	.704825	3.58	.935543	1.23	.769281	4.83	.230719	33
28	.705040	3.57	.935469	1.23	.769571	4.82	.230429	32
29	.705254	3.58	.935395	1.25	.769860	4.80	.230140	31
30	9. 69	3.57	9.935320	1.23	9.770148	4.82	0.229852	30
31	. 83	3.58	.935246	1.25	.770437	4.82	.229563	29
32	. 98	3.57	.935171	1.23	.770726	4.82	.229274	28
33	. 12	3.57	.935097	1.25	.771015	4.80	.228985	27
34	. 26	3.55	.935022	1.23	.771303	4.82	.228697	26
35	9. 39	3.57	9.934948	1.25	9.771592	4.80	0.228408	25
36	. 53	3.57	.934873	1.25	.771880	4.80	.228120	24
37	. 67	3.55	.934798	1.25	.772168	4.82	.227832	23
38	. 80	3.55	.934723	1.23	.772457	4.80	.227543	22
39	.707393	3.55	.934649	1.25	.772745	4.80	.227255	21
40	9.707606	3.55	9.934574	1.25	9.773033	4.80	0.226967	20
41	.707819	3.55	.934499	1.25	.773321	4.78	.226679	19
42	.708032	3.55	.934424	1.25	.773608	4.80	.226392	18
43	.708245	3.55	.934349	1.25	.773896	4.80	.226104	17
44	708458	3.53	.934274	1.25	.774184	4.78	.225816	16
45	9.708670	3.53	9.934199	1.27	9.774471	4.80	0.225529	15
46	.708882	3.53	.934123	1.25	.774759	4.78	.225241	14
47	.709094	3.53	.934048	1.25	.775046	4.78	.224954	13
48	.709306	3.53	.933973	1.25	.775333	4.80	.224667	12
49	.709518	3.53	.933898	1.27	.775621	4.78	.224379	11
50	9.709730	3.52	9.933822	1.25	9.775908	4.78	0.224092	10
51	.709941	3.53	.933747	1.27	.776195	4.78	.223805	9
52	.710153	3.52	.933671	1.25	.776482	4.77	.223518	8
53	.710364	3.52	.933596	1.27	.776768	4.78	.223232	7
54	.710575	3.52	.933520	1.25	.777055	4.78	.222945	6
55	9.710786	3.52	9.933445	1.27	9.777342	4.77	0.222658	5
56	.710997	3.52	.933369	1.27	.777628	4.78	.222372	4
57	.711208	3.52	.933293	1.27	.777915	4.77	.222085	3
58	.711419	3.50	.933217	1.27	.778201	4.78	.221799	2
59	.711629	3.50	.933141	1.25	.778488	4.77	.221512	1
60	9.711839		9.933066		9.778774		0.221226	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M

M.	Sin.	D. 1″.	Cos.	D. 1″	Tan.	D. 1″.	Cot.	
0	9.711839	3.52	9.933066	1.27	9.778774	4.77	0.221226	60
1	.712050	3.50	.932990	1.27	.779060	4.77	.220940	59
2	.712260	3.48	.932914	1.27	.779346	4.77	.220654	58
3	.712469	3.50	.932838	1.27	.779632	4.77	.220368	57
4	.712679	3.50	.932762	1.28	.779918	4.75	.220082	56
5	9.712889	3.48	9.932685	1.27	9.780203	4.77	0.219797	55
6	.713098	3.50	.932609	1.27	.780489	4.77	.219511	54
7	.713308	3.48	.932533	1.27	.780775	4.75	.219225	53
8	.713517	3.48	.932457	1.28	.781060	4.77	.218940	52
9	.713726	3.48	.932380	1.27	.781346	4.75	.218654	51
10	9.713935	3.48	9.932304	1.27	9.781631	4.75	0.218369	50
11	.714144	3.47	.932228	1.28	.781916	4.75	.218084	49
12	714352	3.48	.932151	1.27	.782201	4.75	.217799	48
13	.714561	3.47	.932075	1.28	.782486	4.75	.217514	47
14	.714769	3.48	.931998	1.28	.782771	4.75	.217229	46
15	9.714978	3.47	9.931921	1.27	9.783056	4.75	0.216944	45
16	.715186	3.47	.931845	1.28	.783341	4.75	.216659	44
17	.715394	3.47	.931768	1.28	.783626	4.73	.216374	43
18	.715602	3.45	.931691	1 28	.783910	4.75	.216090	42
19	.715809	3.47	.931614	1.28	.784195	4.73	.215805	41
20	9.716017	3.45	9.931537	1 28	9. 79	4.75	0.215521	40
21	.716224	3.47	.931460	1.28	. 64	4.73	.215236	39
22	.716432	3.45	.931383	1 28	. 48	4.73	.214952	38
23	.716639	3.45	.931306	1.28	. 32	4.73	.214668	37
24	.716846	3.45	.931229	1.28	. 16	4.73	.214384	36
25	9.717053	3.43	9.931152	1.28	9. 00	4.73	0.214100	35
26	.717259	3.45	.931075	1.28	. 84	4.73	.213816	34
27	.717466	3.45	.930998	1.28	. 68	4.73	.213532	33
28	.717673	3.43	.930921	1.30	. 52	4.73	.213248	32
29	.717879	3.43	.930843	1.28	. 36	4.72	.212964	31
30	9.718085	3.43	9.930766	1.30	9.787319	4.73	0.212681	30
31	.718291	3.43	.930688	1 28	.787603	4.72	.212397	29
32	.718497	3.43	.930611	1.30	787886	4.73	.212114	28
33	.718703	3.43	.930533	1.28	.788170	4.72	211830	27
34	.718909	3.42	.930456	1.30	.788453	4.72	.211547	26
35	9.719114	3.43	9.930378	1.30	9.788736	4.72	0.211264	25
36	.719320	3.42	.930300	1 28	.789019	4.72	.210981	24
37	.719525	3.42	.930223	1.30	.789302	4.72	.210698	23
38	.719730	3.42	.930145	1 30	.789585	4.72	.210415	22
39	.719935	3.42	.930067	1.30	.789868	4.72	.210132	21
40	9.720140	3.42	9.929989	1.30	9.790151	4.72	0.209849	20
41	.720345	3.40	.929911	1.30	.790434	4.70	.209566	19
42	.720549	3.42	.929833	1 30	.790716	4.72	.209284	18
43	720754	3.40	.929755	1.30	.790999	4.70	.209001	17
44	.720958	3.40	.929677	1 30	.791281	4.70	.208719	16
45	9.721162	3.40	9.929599	1.30	9.791563	4.72	0.208437	15
46	.721366	3.40	.929521	1 32	.791846	4.70	.208154	14
47	.721570	3.40	.929442	1 30	.792128	4.70	.207872	13
48	.721774	3.40	.929364	1 30	.792410	4.70	.207590	12
49	.721978	3.38	.929286	1 32	.792692	4.70	.207308	11
50	9.722181	3.40	9.929207	1.30	9.792974	4.70	0.207026	10
51	.722385	3.38	.929129	1 32	.793256	4.70	.206744	9
52	.722588	3.38	.929050	1.30	.793538	4.68	.206462	8
53	.722791	3.38	.928972	1.32	.793819	4.70	.206181	7
54	.722994	3.38	.928893	1.30	794101	4.70	.205899	6
55	9.723197	3.38	9.928815	1 32	9.794383	4.68	0.205617	5
56	.723400	3.38	.928736	1.32	.794664	4.70	.205336	4
57	.723603	3.37	.928657	1.32	.794946	4.68	.205054	3
58	.723805	3.37	.928578	1.32	.795227	4.68	.204773	2
59	.724007	3.38	.928499	1.32	795508	4.68	.204492	1
60	9.724210		9.928420		9.795789		0.204211	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	[illegible]	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.724210	3.37	9.928420	1.30	9.795789	4.68	0.204211	60
1	.724412	3.37	.928342	1.32	.796070	4.68	.203930	59
2	.724614	3.37	.928263	1.33	.796351	4.68	.203649	58
	.724816	3.35	.928183	1.32	.796632	4.68	.203368	57
	.725017	3.37	.928104	1.32	.796913	4.68	.203087	56
	9.725219	3.35	9.928025	1.32	9.797194	4.67	0.202806	55
	.725420	3.37	.927946	1.32	.797474	4.68	.202526	54
	.725622	3.35	.927867	1.33	.797755	4.68	.202245	53
	.725823	3.35	.927787	1.32	.798036	4.67	.201964	52
	.726024	[illegible]	.927708	1.32	.798316	4.67	.201684	51
	9.726225	3.35	9.927629	1.33	9.798596	4.68	0.201404	50
	.726426	3.33	.927549	1.32	.798877	4.67	.201123	49
	.726626	3.35	.927470	1.33	.799157	4.67	.200843	48
	.726827	3.33	.927390	1.33	.799437	4.67	.200563	47
	.727027	3.35	.927310	1.32	.799717	4.67	.200283	46
	9.727228	3.33	9.927231	1.33	9.799997	4.67	0.200003	45
	.727428	3.33	.927151	1.33	.800277	4.67	.199723	44
	.727628	3.33	.927071	1.33	.800557	4.65	.199443	43
	.727828	3.32	.926991	1.33	.800836	4.67	.199164	42
	.728027	3.33	.926911	1.33	.801116	4.67	.198884	41
	9.728227	3.33	9.926831	1.33	9.801396	4.65	0.198604	40
	.728427	3.32	.926751	1.33	.801675	4.67	.198325	39
	.728626	3.32	.926671	1.33	.801955	4.65	.198045	38
	.728825	3.32	.926591	1.33	.802234	4.65	.197766	37
	.729024	3.32	.926511	1.33	.802513	4.65	.197487	36
	9.729223	3.32	9.926431	1.33	9.802792	4.67	0.197208	35
	.729422	3.32	.926351	1.35	.803072	4.65	.196928	34
	.729621	3.32	.926270	1.33	.803351	4.65	.196649	33
	.729820	3.30	.926190	1.33	.803630	4.65	.196370	32
	.730018	3.32	.926110	1.35	.803909	4.63	.196091	31
	9.730217	3.30	9.926029	1.33	9.804187	4.65	0.195813	30
	.730415	3.30	.925949	1.35	.804466	4.65	.195534	29
	.730613	3.30	.925868	1.33	.804745	4.63	.195255	28
	.730811	3.30	.925788	1.35	.805023	4.65	.194977	27
	.731009	3.28	.925707	1.35	.805302	4.63	.194698	26
	9.731206	3.30	9.925626	1.35	9.805580	4.65	0.194420	25
	.731404	3.30	.925545	1.33	.805859	4.63	.194141	24
	.731602	3.28	.925465	1.35	.806137	4.63	.193863	23
	.731799	3.28	.925384	1.35	.806415	4.63	.193585	22
	.731996	3.28	.925303	1.35	.806693	4.63	.193307	21
	9.732193	3.28	9.925222	1.35	9.806971	4.63	0.193029	20
	.732390	3.28	.925141	1.35	.807249	4.63	.192751	19
	.732587	3.28	.925060	1.35	.807527	4.63	.192473	18
	.732784	3.27	.924979	1.37	.807805	4.63	.192195	17
	.732980	3.28	.924897	1.35	.808083	4.63	.191917	16
	9.733177	3.27	9.924816	1.35	9.808361	4.62	0.191639	15
	.733373	3.27	.924735	1.35	.808638	4.63	.191362	14
	.733569	3.27	.924654	1.37	.808916	4.62	.191084	13
	.733765	3.27	.924572	1.35	.809193	4.63	.190807	12
	.733961	3.27	.924491	1.37	.809471	4.62	.190529	11
	9.734157	3.27	9.924409	1.35	9.809748	4.62	0.190252	10
	.734353	3.27	.924328	1.37	.810025	4.62	.189975	9
	.734549	3.25	.924246	1.37	.810302	4.63	.189698	8
	.734744	3.25	.924164	1.35	.810580	4.62	.189420	7
	.734939	3.27	.924083	1.37	.810857	4.62	.189143	6
	9.735135	3.25	9.924001	1.37	9.811134	4.60	0.188866	5
	.735330	3.25	.923919	1.37	.811410	4.62	.188590	4
	.735525	3.23	.923837	1.37	.811687	4.62	.188313	3
	.735719	3.25	.923755	1.37	.811964	4.62	.188036	2
	.735914	3.25	.923673	1.37	.812241	4.60	.187759	1
	9.736109		9.923591		9.812517		0.187483	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M.

M	Sin.	D. 1″.	Cos.	D. 1″		″.	Cot.	
0	9.736109	3.23	9.923591	1.37	9.812517	4.62	0.187483	60
1	.736303	3.25	.923509	1.37	794	4.60	.187206	59
2	.736498	3.23	.923427	1.37	070	4.62	.186930	58
3	.736692	3.23	.923345	1.37	347	4.60	.186653	57
4	.736886	3.23	.923263	1.37	623	4.60	.186377	56
5	9.737080	3.23	9.923181	1.38	9 899	4.62	0.186101	55
6	.737274	3.22	.923098	1.37	176	4.60	.185824	54
7	.737467	3.23	.923016	1.38	452	4.60	.185548	53
8	.737661	3.23	.922933	1.37	.814728	4.60	.185272	52
9	.737855	3.22	.922851	1.38	.815004	4.60	.184996	51
10	48	3.22	9.922768	1.37	9 280	4.58	0.184720	50
11	41	3.22	.922686	1.38	555	4.60	.184445	49
12	34	3.22	.922603	1.38	831	4.60	.184169	48
13	27	3.22	.922520	1.37	107	4.58	.183893	47
14	20	3.22	.922438	1.38	382	4.60	.183618	46
15	13	3.22	9.922355	1.38	9 658	4.58	0.183342	45
16	06	3.20	.922272	1.38	933	4.60	.183067	44
17	98	3.20	.922189	1.38	209	4.58	.182791	43
18	90	3.22	.922106	1.38	484	4.58	.182516	42
19	83	3.20	.922023	1.38	759	4.60	.182241	41
20	9.739975	3.20	9.921940	1.38	9.818035	4.58	0.181965	40
21	.740167	3.20	921857	1.38	.818310	4.58	.181690	39
22	.740359	3.18	.921774	1.38	.818585	4.58	.181415	38
23	.740550	3.20	.921691	1.40	.818860	4.58	.181140	37
24	.740742	3.20	.921607	1.38	819135	4.58	.180865	36
25	9.740934	3.18	9.921524	1.38	9.819410	4.57	0.180590	35
26	.741125	3.18	.921441	1.40	.819684	4.58	.180316	34
27	.741316	3.20	.921357	1.38	.819959	4.58	.180041	33
28	.741508	3.18	.921274	1.40	.820234	4.57	.179766	32
29	.741699	3.17	.921190	1.38	.820508	4.58	.179492	31
30	9.741889	3.18	9.921107	1.40	9.820783	4.57	0.179217	30
31	.742080	3.18	.921023	1.40	.821057	4.58	.178943	29
32	.742271	3.18	.920939	1.38	.821332	4.57	.178668	28
33	.742462	3.17	.920856	1.40	.821606	4.57	.178394	27
34	.742652	3.17	.920772	1.40	.821880	4.57	.178120	26
35	9.742842	3.18	9.920688	1.40	9.822154	4.58	0.177846	25
36	.743033	3.17	.920604	1.40	.822429	4.57	.177571	24
37	.743223	3.17	.920520	1.40	.822703	4.57	.177297	23
38	.743413	3.15	.920436	1.40	.822977	4.57	.177023	22
39	.743602	3.17	.920352	1.40	.823251	4.55	.176749	21
40	9.743792	3.17	9.920268	1.40	9.823524	4.57	0.176476	20
41	.743982	3.15	.920184	1.42	.823798	4.57	.176202	19
42	.744171	3.17	.920099	1.40	.824072	4.55	.175928	18
43	.744361	3.15	.920015	1.40	.824345	4.57	.175655	17
44	.744550	3.15	.919931	1.42	.824619	4.57	.175381	16
45	9.744739	3.15	9.919846	1.40	9.824893	4.55	0.175107	15
46	.744928	3.15	.919762	1.42	.825166	4.55	.174834	14
47	.745117	3.15	919677	1.40	.825439	4.57	.174561	13
48	.745306	3.13	.919593	1.42	.825713	4.55	.174287	12
49	.745494	3.15	.919508	1.40	.825986	4.55	.174014	11
50	9.745683	3.13	9.919424	1.42	9.826259	4.55	0.173741	10
51	.745871	3.15	.919339	1.42	826532	4.55	.173468	9
52	.746060	3.13	.919254	1.42	.826805	4.55	.173195	8
53	.746248	3.13	.919169	1.40	.827078	4.55	.172922	7
54	.746436	3.13	.919085	1.42	.827351	4.55	.172649	6
55	9.746624	3.13	9.919000	1.42	9.827624	4.55	0.172376	5
56	.746812	3.12	.918915	1.42	.827897	4.55	.172103	4
57	.746999	3.13	.918830	1.42	.828170	4.53	.171830	3
58	.747187	3.12	.918745	1.43	.828442	4.55	.171558	2
59	.747374	3.13	.918659	1.42	.828715	4.53	.171285	1
60	9.747562		9.918574		9.828987		0.171013	0
				D. 1″.	Cot.	D		

M	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.747562	3.12	9.918574	1.42	9.8[illegible]87	4.55	0.171013	60
1	.747749	3.12	.918489	1.42	.8[illegible]60	4.53	.170740	59
2	.747936	3.12	.918404	1.43	.8[illegible]32	4.55	.170468	58
3	.748123	3.12	.918318	1.42	.8[illegible]05	4.53	.170195	57
4	.748310	3.12	.918233	1.43	.8[illegible]77	4.53	.169923	56
5	9.748497	3.10	9.918147	1.42	9.8[illegible]49	4.53	0.169651	55
6	.748683	3.12	.918062	1.43	.8[illegible]21	4.53	.169379	54
7	.748870	3.10	.917976	1.42	.8[illegible]93	4.53	.169107	53
8	.749056	3.12	.917891	1.43	.8[illegible]65	4.53	.168835	52
9	.749243	3.10	.917805	1.43	.8[illegible]37	4.53	.168563	51
10	9.749429	3.10	9.917719	1.42	9.8[illegible]09	4.53	0.168291	50
11	.749615	3.10	.917634	1.43	.8[illegible]81	4.53	.168019	49
12	.749801	3.10	.917548	1.43	.8[illegible]53	4.53	.167747	48
13	.749987	3.08	.917462	1.43	.8[illegible]25	4.52	.167475	47
14	750172	3.10	.917376	1.43	.8[illegible]96	4.53	.167204	46
15	9.750358	3.08	9.917290	1.43	9.8[illegible]68	4.52	0.166932	45
16	750543	3.10	.917204	1.43	.8[illegible]39	4.53	.166661	44
17	.750729	3.08	917118	1.43	.8[illegible]11	4.52	.166389	43
18	.750914	3.08	.917032	1.43	.8[illegible]82	4.53	.166118	42
19	.751099	3.08	.916946	1.45	.8[illegible]54	4.52	.165846	41
20	9.751284	3.08	9.916859	1.43	9.[illegible]25	4.52	0.165575	40
21	.751469	3.08	.916773	1.43	.[illegible]96	4.52	.165304	39
22	.751654	3.08	.916687	1.45	.[illegible]67	4.52	.165033	38
23	.751839	3.07	.916600	1.43	.[illegible]38	4.52	.164762	37
24	.752023	3.08	916514	1.45	.[illegible]09	4.52	.164491	36
25	9.752208	3.07	9.916427	1.43	9.[illegible]80	4.52	0.164220	35
26	.752392	3.07	.916341	1.45	.[illegible]51	4.52	.163949	34
27	.752576	3.07	.916254	1.45	.[illegible]22	4.52	.163678	33
28	.752760	3.07	.916167	1.43	.[illegible]93	4.52	.163407	32
29	.752944	3.07	.916081	1.45	.[illegible]64	4.50	.163136	31
30	9.753128	3.07	9.915994	1.45	9.[illegible]34	4.52	0.162866	30
31	.753312	3.05	.915907	1.45	.[illegible]05	4.50	.162595	29
32	.753495	3.07	.915820	1.45	.[illegible]75	4.52	.162325	28
33	753679	3.05	.915733	1.45	.[illegible]46	4.50	.162054	27
34	.753862	3.07	915646	1.45	.[illegible]16	4.52	.161784	26
35	9.754046	3.05	9.915559	1.45	9.[illegible]87	4.50	0.161513	25
36	.754229	3.05	.915472	1.45	.[illegible]57	4.50	.161243	24
37	.754412	3.05	.915385	1.47	.[illegible]27	4.50	.160973	23
38	.754595	3.05	.915297	1.45	.[illegible]97	4.52	.160703	22
39	.754778	3.03	.915210	1.45	.[illegible]68	4.50	.160432	21
40	9.754960	3.05	9.915123	1.47	9.839838	4.50	0.160162	20
41	.755143	3.05	.915035	1.45	.840108	4.50	.159892	19
42	.755326	3.03	.914948	1.47	.840378	4.50	.159622	18
43	.755508	3.03	.914860	1.45	.840648	4.48	.159352	17
44	.755690	3.03	.914773	1.47	840917	4.50	.159083	16
45	9.755872	3.03	9.914685	1.45	9.841187	4.50	0.158813	15
46	.756054	3.03	.914598	1.47	.841457	4.50	.158543	14
47	.756236	3.03	.914510	1.47	.841727	4.48	.158273	13
48	.756418	3.03	.914422	1.47	.841996	4.50	.158004	12
49	.756600	3.03	.914334	1.47	.842266	4.48	.157734	11
50	9.756782	3.02	9.914246	1.47	9.842535	4.50	0.157465	10
51	.756963	3.02	.914158	1.47	.842805	4.48	.157195	9
52	.757144	3.03	.914070	1.47	.843074	4.48	.156926	8
53	757326	3.02	.913982	1.47	.843343	4.48	.156657	7
54	.757507	3.02	.913894	1.47	.843612	4.50	.156388	6
55	9.757688	3.02	9.913806	1.47	9.843882	4.48	0.156118	5
56	.757869	3.02	.913718	1.47	.844151	4.48	.155849	4
57	.758050	3.00	.913630	1.48	.844420	4.48	.155580	3
58	758230	3.02	.913541	1.47	.844689	4.48	.155311	2
59	.758411	3.00	.913453	1.47	.844958	4.48	.155042	1
60	9.758591		9.913365		9.845227		0.154773	0
	Cos.	D. 1".	Sin.	D. 1"	Cot.	D. 1".	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.758591	3.02	9.913365	1.48	9.845227	4.48	0.154773	60
1	.758772	3.00	.913276	1.48	.845496	4.47	.154504	59
2	.758952	3.00	.913187	1.47	.845764	4.48	. 36	58
3	.759132	3.00	.913099	1.48	.846033	4.48	. 67	57
4	.759312	3.00	.913010	1.47	.846302	4.47	. 98	56
5	9.759492	3.00	9.912922	1.48	9.846570	4.48	0. 30	55
6	.759672	3.00	.912833	1.48	.846839	4.48	. 61	54
7	.759852	2.98	.912744	1.48	.847108	4.47	. 92	53
8	.760031	3.00	.912655	1.48	.847376	4.47	. 24	52
9	.760211	2.98	.912566	1.48	.847644	4.48	. 56	51
10	9.760390	2.98	9.912477	1.48	9.847913	4.47	0.152087	50
11	.760569	2.98	.912388	1.48	.848181	4.47	.151819	49
12	.760748	2.98	.912299	1.48	.848449	4.47	.151551	48
13	.760927	2.98	.912210	1.48	.848717	4.48	.151283	47
14	.761106	2.98	.912121	1.50	.848986	4.47	.151014	46
15	9.761285	2.98	9.912031	1.48	9.849254	4.47	0.150746	45
16	.761464	2.97	.911942	1.48	.849522	4.47	.150478	44
17	.761642	2.98	.911853	1.50	.849790	4.45	.150210	43
18	.761821	2.97	.911763	1.48	.850057	4.47	.149943	42
19	.761999	2.97	.911674	1.50	.850325	4.47	.149675	41
20	9.762177	2.98	9.911584	1.48	9.850593	4.47	0.149407	40
21	.762356	2.97	.911495	1.50	.850861	4.47	.149139	39
22	.762534	2.97	.911405	1.50	.851129	4.45	.148871	38
23	.762712	2.95	.911315	1.48	.851396	4.47	.148604	37
24	.762889	2.97	.911226	1.50	.851664	4.45	.148336	36
25	9.763067	2.97	9.911136	1.50	9.851931	4.47	0.148069	35
26	.763245	2.95	.911046	1.50	.852199	4.45	.147801	34
27	.763422	2.97	.910956	1.50	.852466	4.45	.147534	33
28	.763600	2.95	.910866	1.50	.852733	4.47	.147267	32
29	.763777	2.95	.910776	1.50	.853001	4.45	.146999	31
30	9.763954	2.95	9.910686	1.50	9.853268	4.45	0.146732	30
31	.764131	2.95	.910596	1.50	.853535	4.45	.146465	29
32	.764308	2.95	.910506	1.52	.853802	4.45	.146198	28
33	.764485	2.95	.910415	1.50	.854069	4.45	.145931	27
34	.764662	2.93	.910325	1.50	.854336	4.45	.145664	26
35	9.764838	2.95	9.910235	1.52	9.854603	4.45	0.145397	25
36	.765015	2.93	.910144	1.50	.854870	4.45	.145130	24
37	.765191	2.93	.910054	1.52	.855137	4.45	.144863	23
38	.765367	2.95	.909963	1.50	.855404	4.45	.144596	22
39	.765544	2.93	.909873	1.52	.855671	4.45	.144329	21
40	9.765720	2.93	9.909782	1.52	9.855938	4.43	0.144062	20
41	.765896	2.93	.909691	1.50	.856204	4.45	.143796	19
42	.766072	2.92	.909601	1.52	.856471	4.43	.143529	18
43	.766247	2.93	.909510	1.52	.856737	4.45	.143263	17
44	.766423	2.92	.909419	1.52	.857004	4.43	.142996	16
45	9.766598	2.93	9.909328	1.52	9.857270	4.45	0.142730	15
46	.766774	2.92	.909237	1.52	.857537	4.43	.142463	14
47	.766949	2.92	.909146	1.52	.857803	4.43	.142197	13
48	.767124	2.93	.909055	1.52	.858069	4.45	.141931	12
49	.767300	2.92	.908964	1.52	.858336	4.43	.141664	11
50	9.767475	2.90	9.908873	1.53	9.858602	4.43	0.141398	10
51	.767649	2.92	.908781	1.52	.858868	4.43	.141132	9
52	.767824	2.92	.908690	1.52	.859134	4.43	.140866	8
53	.767999	2.90	.908599	1.53	.859400	4.43	.140600	7
54	.768173	2.92	.908507	1.52	.859666	4.43	.140334	6
55	9.768348	2.90	9.908416	1.53	9.859932	4.43	0.140068	5
56	.768522	2.92	.908324	1.52	.860198	4.43	.139802	4
57	.768697	2.90	.908233	1.53	.860464	4.43	.139536	3
58	.768871	2.90	.908141	1.53	.860730	4.42	.139270	2
59	.769045	2.90	.908049	1.52	.860995	4.43	.139005	1
60	9.769219		9.907958		9.861261		0.138739	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M	Sin.	D. 1"	Cos.	D. 1".	Tan.	D. 1".	Cot.
0	9.769219	2.90	9.907958	1.53	9.861261	4.43	0.138739
1	.769393	2.88	.907866	1.53	.861527	4.42	.138473
2	.769566	2.90	.907774	1.53	.861792	4.43	.138208
3	.769740	2.88	.907682	1.53	.862058	4.42	.137942
4	.769913	2.90	.907590	1.53	.862323	4.43	.137677
5	9.770087	2.88	9.907498	1.53	9.862589	4.42	0.137411
6	.770260	2.88	.907406	1.53	.862854	4.42	.137146
7	.770433	2.88	.907314	1.53	.863119	4.43	.136881
8	.770606	2.88	.907222	1.55	.863385	4.42	.136615
9	.770779	2.88	.907129	1.53	.863650	4.42	.136350
10	9.770952	2.88	9. 137	1.53	9.863915	4.42	0.136085
11	.771125	2.88	. 45	1.55	.864180	4.42	.135820
12	.771298	2.87	. 52	1.53	.864445	4.42	.135555
13	.771470	2.88	. 60	1.55	.864710	4.42	.135290
14	.771643	2.87	. 67	1.53	.864975	4.42	.135025
15	9.771815	2.87	9. 75	1.55	9.865240	4.42	0.134760
16	.771987	2.87	. 82	1.55	.865505	4.42	.134495
17	.772159	2.87	. 89	1.55	.865770	4.42	.134230
18	.772331	2.87	. 96	1.53	.866035	4.42	.133965
19	.772503	2.87	. 04	1.55	.866300	4.40	.133700
20	9.772675	2.87	9.906111	1.55	9.866564	4.42	0.133436
21	.772847	2.85	.906018	1.55	.866829	4.42	.133171
22	.773018	2.87	.905925	1.55	.867094	4.40	.132906
23	.773190	2.85	.905832	1.55	.867358	4.42	.132642
24	.773361	2.87	905739	1.57	.867623	4.40	.132377
25	9.773533	2.85	9.905645	1.55	9.867887	4.42	0.132113
26	.773704	2.85	.905552	1.55	.868152	4.40	.131848
27	.773875	2.85	.905459	1.55	.868416	4.40	.131584
28	.774046	2.85	.905366	1.57	.868680	4.42	.131320
29	.774217	2.85	.905272	1.55	.868945	4.40	.131055
30	9.774388	2.83	9.905179	1.57	9.869209	4.40	0.130791
31	.774558	2.85	.905085	1.55	.869473	4.40	.130527
32	.774729	2.83	.904992	1.57	.869737	4.40	.130263
33	.774899	2.85	.904898	1.57	.870001	4.40	.129999
34	.775070	2.83	.904804	1.55	.870265	4.40	.129735
35	9.775240	2.83	9.904711	1.57	9.870529	4.40	0.129471
36	.775410	2.83	.904617	1.57	.870793	4.40	.129207
37	.775580	2.83	.904523	1.57	.871057	4.40	.128943
38	.775750	2.83	.904429	1.57	.871321	4.40	.128679
39	.775920	2.83	.904335	1.57	.871585	4.40	.128415
40	9. 090	2.82	9.904241	1.57	9.871849	4.38	0.128151
41	. 259	2.83	.904147	1.57	.872112	4.40	.127888
42	. 429	2.82	.904053	1.57	.872376	4.40	.127624
43	. 598	2.83	.903959	1.58	.872640	4.38	.127360
44	. 768	2.82	.903864	1.57	872903	4.40	.127097
45	9. 937	2.82	9.903770	1.57	9.873167	4.38	0.126833
46	. 106	2.82	.903676	1.58	.873430	4.40	.126570
47	. 275	2.82	.903581	1.57	.873694	4.38	.126306
48	. 444	2.82	.903487	1.58	.873957	4.38	.126043
49	. 613	2.80	.903392	1.57	.874220	4.40	.125780
50	9.777781	2.82	9.903298	1.58	9. 484	4.38	0.125516
51	.7 950	2.82	.903203	1.58	. 747	4.38	125253
52	.7 19	2.80	.903108	1.57	. 010	4.38	.124990
53	.7 87	2.80	.903014	1.58	. 273	4.40	124727
54	.7 55	2.82	.902919	1.58	. 537	4.38	.124463
55	9.7 24	2.80	9.902824	1.58	9. 800	4.38	0.124200
56	.7 92	2.80	.902729	1.58	. 063	4.38	.123937
57	.7 60	2.80	.902634	1.58	. 326	4.38	.123674
58	.7 28	2.78	.902539	1.58	. 589	4.38	.123411
59	.7 95	2.80	.902444	1.58	. 852	4.37	123148
60	9.7 63		9.902349		9. 114		0.122886
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1"	Tan.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.779463	2.80	9.902349	1.60	9.877114	4.38	0.122886	60
1	.779631	2.75	.902253	1.58	.877377	4.38	.122623	59
2	.779798	2.80	.902158	1.58	.877640	4.38	.122360	58
3	.779966	2.75	.902063	1.60	.877903	4.37	.122097	57
4	.780133	2.75	.901967	1.58	.878165	4.38	.121835	56
5	9.780300	2.78	9.901872	1.60	9.878428	4.38	0.121572	55
6	.780467	2.75	.901776	1.58	.878691	4.37	.121309	54
7	.780634	2.78	.901681	1.60	.878953	4.38	.121047	53
8	.780801	2.78	.901585	1.58	.879216	4.37	.120784	52
9	.780968	2.77	.901490	1.60	.879478	4.38	.120522	51
10	9.781134	2.78	9.901394	1.60	9.879741	4.37	0.120259	50
11	.781301	2.78	.901298	1.60	.880003	4.37	.119997	49
12	.781468	2.77	.901202	1.60	.880265	4.38	.119735	48
13	.781634	2.77	.901106	1.60	.880528	4.37	.119472	47
14	.781800	2.77	.901010	1.60	.880790	4.37	.119210	46
15	9.781966	2.77	9.900914	1.60	9.881052	4.37	0.118948	45
16	.782132	2.77	.900818	1.60	.881314	4.38	.118686	44
17	.782298	2.77	.900722	1.60	.881577	4.37	.118423	43
18	.782464	2.77	.900626	1.62	.881839	4.37	.118161	42
19	.782630	2.77	.900529	1.60	.882101	4.37	.117899	41
20	9.782796	2.75	9.900433	1.60	9.882363	4.37	0.117637	40
21	.782961	2.77	.900337	1.62	.882625	4.37	.117375	39
22	.783127	2.75	.900240	1.60	.882887	4.35	.117113	38
23	.783292	2.77	.900144	1.62	.883148	4.37	.116852	37
24	.783458	2.75	.900047	1.60	.883410	4.37	.116590	36
25	9.783623	2.75	9.899951	1.62	9.883672	4.37	0.116328	35
26	.783788	2.75	.899854	1.62	.883934	4.37	.116066	34
27	.783953	2.75	.899757	1.62	.884196	4.35	.115804	33
28	.784118	2.73	.899660	1.60	.884457	4.37	.115543	32
29	.784282	2.75	.899564	1.62	.884719	4.35	.115281	31
30	9.784447	2.75	9.899467	1.62	9.884980	4.37	0.115020	30
31	.784612	2.73	.899370	1.62	.885242	4.37	.114758	29
32	.784776	2.75	.899273	1.62	.885504	4.35	.114496	28
33	.784941	2.73	.899176	1.63	.885765	4.35	.114235	27
34	.785105	2.73	.899078	1.62	.886026	4.37	.113974	26
35	9.785269	2.73	9.898981	1.62	9.886288	4.35	0.113712	25
36	.785433	2.73	.898884	1.62	.886549	4.37	.113451	24
37	.785597	2.73	.898787	1.63	.886811	4.35	.113189	23
38	.785761	2.73	.898689	1.62	887072	4.35	.112928	22
39	.785925	2.73	.898592	1.63	.887333	4.35	.112667	21
40	9.786089	2.72	9.[illegible]94	1.62	9.887594	4.35	0.112406	20
41	.786252	2.73	.[illegible]97	1.63	.887855	4.35	.112145	19
42	.786416	2.72	.[illegible]99	1.62	.888116	4.37	.111884	18
43	.786579	2.72	.[illegible]02	1.63	.888378	4.35	.111622	17
44	.786742	2.73	.[illegible]04	1.63	.888639	4.35	.111361	16
45	9.786906	2.72	9.[illegible]06	1.63	9.888900	4.35	0.111100	15
46	787069	2.72	.[illegible]08	1.63	889161	4.33	.110839	14
47	.787232	2.72	.[illegible]10	1.63	.889421	4.35	.110579	13
48	.787395	2.70	.[illegible]12	1.63	.889682	4.35	.110318	12
49	.787557	2.72	.[illegible]14	1.63	.889943	4.35	.110057	11
50	9.[illegible]20	2.72	9.897516	1.63	9.890204	4.35	0.109796	10
51	.[illegible]83	2.70	.897418	1.63	.890465	4.33	.109535	9
52	.[illegible]45	2.72	.897320	1.63	.890725	4.35	.109275	8
53	.[illegible]08	2.70	.897222	1.65	.890986	4.35	.109014	7
54	.[illegible]70	2.70	.897123	1.63	891247	4.33	.108753	6
55	9.[illegible]32	2.70	9.897025	1.65	9.891507	4.35	0.108493	5
56	.[illegible]94	2.70	.896926	1.63	.891768	4.33	.108232	4
57	.[illegible]56	2.70	.896828	1.65	.892028	4.35	.107972	3
58	.[illegible]18	2.70	.896729	1.63	.892289	4.33	.107711	2
59	.[illegible]80	2.70	896631	1.65	.892549	4.35	.107451	1
60	9.[illegible]42		9.896532		9.892810		0.107190	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.789342	2.70	9.896532	1.65	9.892810	4.33	0.107190	60
1	.789504	2.68	.896433	1.63	.893070	4.35	.106930	59
2	.789665	2.70	.896335	1.65	.893331	4.33	.106669	58
3	.789827	2.68	.896236	1.65	.893591	4.33	.106409	57
4	.789988	2.68	.896137	1.65	.893851	4.33	.106149	56
5	9.790149	2.68	9.896038	1.65	9.894111	4.35	0.105889	55
6	.790310	2.68	.895939	1.65	.894372	4.33	.105628	54
7	.790471	2.68	.895840	1.65	.894632	4.33	.105368	53
8	.790632	2.68	.895741	1.67	.894892	4.33	.105108	52
9	.790793	2.68	.895641	1.65	.895152	4.33	.104848	51
10	9.790954	2.68	9.895542	1.65	9. 12	4.33	0.104588	50
11	.791115	2.67	.895443	1.67	. 72	4.33	.104328	49
12	.791275	2.68	.895343	1.65	. 32	4.33	.104068	48
13	.791436	2.67	.895244	1.65	. 92	4.33	.103808	47
14	.791596	2.68	.895145	1.67	. 52	4.33	.103548	46
15	9.791757	2.67	9.895045	1.67	9. 12	4.32	0.103288	45
16	.791917	2.67	.894945	1.65	. 71	4.33	.103029	44
17	.792077	2.67	.894846	1.67	. 31	4.33	.102769	43
18	.792237	2.67	.894746	1.67	. 91	4.33	.102509	42
19	.792397	2.67	.894646	1.67	. 51	4.32	.102249	41
20	9.792557	2.65	9 46	1.67	9. 10	4.33	0.101990	40
21	.792716	2.67	46	1.67	. 70	4.33	.101730	39
22	.792876	2.65	46	1.67	. 30	4.32	.101470	38
23	.793035	2.67	46	1.67	. 89	4.33	.101211	37
24	.793195	2.65	46	1.67	. 49	4.32	.100951	36
25	9.793354	2.67	9 46	1.67	9. 08	4.33	0.100692	35
26	.793514	2.65	46	1.67	. 68	4.32	.100432	34
27	.793673	2.65	46	1.68	. 27	4.33	.100173	33
28	.793832	2.65	45	1.67	. 87	4.32	.099913	32
29	.793991	2.65	45	1.68	. 46	4.32	.099654	31
30	9.794150	2.63	9.893544	1.67	9.900605	4.32	0.099395	30
31	.794308	2.65	.893444	1.68	.900864	4.33	.099136	29
32	.794467	2.65	.893343	1.67	.901124	4.32	.098876	28
33	.794626	2.63	.893243	1.68	.901383	4.32	.098617	27
34	.794784	2.63	.893142	1.68	.901642	4.32	.098358	26
35	9.794942	2.65	9.893041	1.68	9.901901	4.32	0.098099	25
36	.795101	2.63	.892940	1.68	.902160	4.33	.097840	24
37	.795259	2.63	.892839	1.67	.902420	4.32	.097580	23
38	.795417	2.63	.892739	1.68	.902679	4.32	.097321	22
39	.795575	2.63	.892638	1.70	.902938	4.32	.097062	21
40	9. 33	2.63	9.892536	1.68	9.903197	4.32	0.096803	20
41	. 91	2.63	.892435	1.68	.903456	4.30	.096544	19
42	. 49	2.62	.892334	1.68	.903714	4.32	.096286	18
43	. 06	2.63	.892233	1.68	.903973	4.32	.096027	17
44	. 64	2.62	.892132	1.70	.904232	4.32	.095768	16
45	9. 21	2.63	9.892030	1.68	9.904491	4.32	0.095509	15
46	. 79	2.62	.891929	1.70	.904750	4.30	.095250	14
47	. 36	2.62	.891827	1.68	.905008	4.32	.094992	13
48	. 93	2.62	.891726	1.70	.905267	4.32	.094733	12
49	.797150	2.62	.891624	1.68	.905526	4.32	.094474	11
50	9.797307	2.62	9.891523	1.70	9.905785	4.30	0.094215	10
51	.797464	2.62	.891421	1.70	.906043	4.32	.093957	9
52	.797621	2.60	.891319	1.70	.906302	4.30	.093698	8
53	.797777	2.62	.891217	1.70	.906560	4.32	.093440	7
54	.797934	2.62	.891115	1.70	.906819	4.30	.093181	6
55	9.798091	2.60	9.891013	1.70	9.907077	4.32	0.092923	5
56	.798247	2.60	.890911	1.70	.907336	4.30	.092664	4
57	.798403	2.62	.890809	1.70	.907594	4.32	.092406	3
58	.798560	2.60	.890707	1.70	.907853	4.30	.092147	2
59	.798716	2.60	.890605	1.70	.908111	4.30	.091889	1
60	9.798872		9.890503		9.908369		0.091631	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.	M

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	C[illegible]	
0	9.798872	2.60	9.890503	1.72	9.908369	4.32	0.091631	60
1	.799028	2.60	.890400	1.70	.908628	4.30	.091372	59
2	.799184	2.58	.890298	1.72	.908886	4.30	.091114	58
3	.799339	2.60	.890195	1.70	.909144	4.30	.090856	57
4	.799495	2.60	.890093	1.72	.909402	4.30	.090598	56
5	9.799651	2.58	9.889990	1.70	9.909660	4.30	0.090340	55
6	.799806	2.60	.889888	1.72	.909918	4.32	.090082	54
7	.799962	2.58	.889785	1.72	.910177	4.30	.089823	53
8	.800117	2.58	.889682	1.72	.910435	4.30	.089565	52
9	.800272	2.58	.889579	1.70	.910693	4.30	.089307	51
10	9.800427	2.58	9.889477	1.72	9.910951	4.30	0.089049	50
11	.800582	2.58	.889374	1.72	.911209	4.30	.088791	49
12	.800737	2.58	.889271	1.72	.911467	4.30	.088533	48
13	.800892	2.58	.889168	1.73	.911725	4.28	.088275	47
14	.801047	2.57	.889064	1.72	.911982	4.30	.088018	46
15	9.801201	2.58	9.888961	1.72	9.912240	4.30	0.087760	45
16	.801356	2.58	.888858	1.72	.912498	4.30	.087502	44
17	.801511	2.57	.888755	1.73	.912756	4.30	.087244	43
18	.801665	2.57	.888651	1.72	.913014	4.28	.086986	42
19	.801819	2.57	.888548	1.73	.913271	4.30	.086729	41
20	9.801973	2.58	44	1.72	9.913529	4.30	0.086471	40
21	.802128	2.57	41	1.73	.913787	4.28	.086213	39
22	.802282	2.57	37	1.72	.914044	4.30	.085956	38
23	.802436	2.55	34	1.73	.914302	4.30	.085698	37
24	.802589	2.57	30	1.73	.914560	4.28	.085440	36
25	9.802743	2.57	26	1.73	9.914817	4.30	0.085183	35
26	.802897	2.55	22	1.73	.915075	4.28	.084925	34
27	.803050	2.57	18	1.73	.915332	4.30	.084668	33
28	.803204	2.55	14	1.73	.915590	4.28	.084410	32
29	.803357	2.57	10	1.73	.915847	4.28	.084153	31
30	9.803511	2.55	9.887406	1.73	9.916104	4.30	0.083896	30
31	.803664	2.55	.887302	1.73	.916362	4.28	.083638	29
32	.803817	2.55	.887198	1.75	.916619	4.30	.083381	28
33	.803970	2.55	.887093	1.73	.916877	4.28	.083123	27
34	.804123	2.55	.886989	1.73	.917134	4.28	.082866	26
35	9.804276	2.53	9.886885	1.75	9.917391	4.28	0.082609	25
36	.804428	2.55	.886780	1.73	.917648	4.30	.082352	24
37	.804581	2.55	.886676	1.75	.917906	4.28	.082094	23
38	.804734	2.53	.886571	1.75	.918163	4.28	.081837	22
39	.804886	2.55	.886466	1.73	.918420	4.28	.081580	21
40	9.805039	2.53	9.886362	1.75	9.918677	4.28	0.081323	20
41	.805191	2.53	.886257	1.75	.918934	4.28	.081066	19
42	.805343	2.53	.886152	1.75	.919191	4.28	.080809	18
43	.805495	2.53	.886047	1.75	.919448	4.28	.080552	17
[illegible]	.805647	2.53	.885942	1.75	.919705	4.28	.080295	16
45	9.805799	2.53	9.885837	1.75	9.919962	4.28	0.080038	15
46	.805951	2.53	.885732	1.75	.920219	4.28	.079781	14
47	.806103	2.52	.885627	1.75	.920476	4.28	.079524	13
48	.806254	2.53	.885522	1.77	.920733	4.28	.079267	12
49	.806406	2.52	.885416	1.75	.920990	4.28	.079010	11
50	9.806557	2.53	9.885311	1.77	9.921247	4.27	0.078753	10
51	.806709	2.52	.885205	1.75	.921503	4.28	.078497	9
52	.806860	2.52	.885100	1.77	.921760	4.28	.078240	8
[illegible]	.807011	2.53	.884994	1.75	.922017	4.28	.077983	7
54	.807163	2.52	.884889	1.77	.922274	4.27	.077726	6
55	9.807314	2.52	9.884783	1.77	9.922530	4.28	0.077470	5
56	.807465	2.50	.884677	1.75	.922787	4.28	.077213	4
57	.807615	2.52	.884572	1.77	.923044	4.27	.076956	3
58	.807766	2.52	.884466	1.77	.923300	4.28	.076700	2
59	.807917	2.50	.884360	1.77	.923557	4.28	.076443	1
60	9.808067		9.884254		9.923814		0.076186	0
	Cos.	D. 1″.	Sin.	D. 1″.	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.808067	2.52	9.884254	1.77	9.923814	4.27	0.076186	60
1	.808218	2.50	.884148	1.77	.924070	4.28	.075930	59
2	.[illegible]68	2.52	.884042	1.77	.924327	4.27	.075673	58
3	.[illegible]19	2.50	.883936	1.78	.924583	4.28	.075417	57
4	.[illegible]69	2.50	.883829	1.77	.924840	4.27	.075160	56
5	9.[illegible]19	2.50	9.883723	1.77	9.925096	4.27	0.074904	55
6	.[illegible]69	2.50	.883617	1.78	.925352	4.28	.074648	54
7	.[illegible]19	2.50	.883510	1.77	.925609	4.27	.074391	53
8	.[illegible]69	2.50	.883404	1.78	.925865	4.28	.074135	52
9	.[illegible]19	2.50	.883297	1.77	.926122	4.27	.073878	51
10	9.809569	2.48	9.883191	1.78	9.926378	4.27	0.073622	50
11	.809718	2.50	.883084	1.78	.926634	4.27	.073366	49
12	.809868	2.48	.882977	1.77	.926890	4.28	.073110	48
13	.810017	2.50	.882871	1.78	.927147	4.27	.072853	47
14	.810167	2.48	.882764	1.78	.927403	4.27	.072597	46
15	9.810316	2.48	9.882657	1.78	9.927659	4.27	0.072341	45
16	.810465	2.48	.882550	1.78	.927915	4.27	.072085	44
17	.810614	2.48	.882443	1.78	.928171	4.27	.071829	43
18	.810763	2.48	.882336	1.78	.928427	4.28	.071573	42
19	.810912	2.48	.882229	1.80	.928684	4.27	.071316	41
20	9.811061	2.48	9.882121	1.78	9.928940	4.27	0.071060	40
21	.811210	2.47	.882014	1.78	.929196	4.27	.070804	39
22	.[illegible]58	2.48	.881907	1.80	.929452	4.27	.070548	38
23	.[illegible]07	2.47	.881799	1.78	.929708	4.27	.070292	37
24	.[illegible]55	2.48	.881692	1.80	.929964	4.27	.070036	36
25	9.[illegible]04	2.47	9.881584	1.78	9.930220	4.25	0.069780	35
26	.[illegible]52	2.47	.881477	1.80	.930475	4.27	.069525	34
27	.[illegible]00	2.47	.881369	1.80	.930731	4.27	.069269	33
28	.[illegible]48	2.47	.881261	1.80	.930987	4.27	.069013	32
29	.[illegible]96	2.47	.881153	1.78	.931243	4.27	.068757	31
30	9.[illegible]44	2.47	9.881046	1.80	9.931499	4.27	0.068501	30
31	.[illegible]92	2.47	.880938	1.80	.931755	4.25	.068245	29
32	.[illegible]40	2.47	.880830	1.80	.932010	4.27	.067990	28
33	.[illegible]88	2.45	.880722	1.82	.932266	4.27	.067734	27
34	.[illegible]35	2.47	.880613	1.80	.932522	4.27	.067478	26
35	9.[illegible]83	2.45	9.880505	1.80	9.932778	4.25	0.067222	25
36	.[illegible]30	2.47	.880397	1.80	.933033	4.27	.066967	24
37	.[illegible]78	2.45	.880289	1.82	.933289	4.27	.066711	23
38	.[illegible]25	2.45	.880180	1.80	.933545	4.25	.066455	22
39	.[illegible]72	2.45	.880072	1.82	.933800	4.27	.066200	21
40	9.[illegible]19	2.45	9.879963	1.80	9.934056	4.25	0.065944	20
41	.[illegible]66	2.45	.879855	1.82	.934311	4.27	.065689	19
42	.[illegible]13	2.45	.879746	1.82	.934567	4.25	.065433	18
43	.[illegible]60	2.45	.879637	1.80	.934822	4.27	.065178	17
44	.[illegible]07	2.43	.879529	1.82	.935078	4.25	.064922	16
45	9.[illegible]53	2.45	9.879420	1.82	9.935333	4.27	0.064667	15
46	.[illegible]00	2.43	.879311	1.82	.935589	4.25	.064411	14
47	.[illegible]46	2.45	.879202	1.82	.935844	4.27	.064156	13
48	.[illegible]93	2.43	.879093	1.82	.936100	4.25	.063900	12
49	.[illegible]39	2.43	.878984	1.82	.936355	4.27	.063645	11
50	9.[illegible]85	2.45	9.878875	1.82	9.936611	4.25	0.063389	10
51	.[illegible]32	2.43	.878766	1.83	.936866	4.25	.063134	[illegible]
52	.[illegible]78	2.43	.878656	1.82	.937121	4.27	.062879	[illegible]
53	.[illegible]24	2.42	.878547	1.82	.937377	4.25	.062623	7
54	.[illegible]69	2.43	.878438	1.83	.937632	4.25	.062368	6
55	9.[illegible]15	2.43	9.878328	1.82	9.937887	4.25	0.062113	5
56	.[illegible]61	2.43	.878219	1.83	.938142	4.27	.061858	4
57	.[illegible]07	2.42	.878109	1.83	.938398	4.25	.061602	3
58	.[illegible]52	2.43	.877999	1.82	.938653	4.25	.061347	2
59	.[illegible]98	2.42	.877890	1.83	.938908	4.25	.061092	1
60	9.[illegible]43		9.877780		9.939163		0.060837	0
	Cos.	D. 1".	Sin.	D. 1".				

M.	Sin.	D. 1"	Cos.	D. 1".	Tan.	D. 1".	Cot.	
0	9.816943	2.42	9.877780	1.83	9.939163	4.25	0.060837	60
1	.817088	2.42	.877670	1.83	.939418	4.25	.060582	59
2	.817233	2.43	.877560	1.83	.939673	4.25	.060327	58
3	.817379	2.42	.877450	1.83	.939928	4.25	.060072	57
4	.817524	2.40	.877340	1.83	.940183	4.27	.059817	56
5	9.817668	2.42	9.877230	1.83	9.940439	4.25	0.059561	55
6	.817813	2.42	.877120	1.83	.940694	4.25	.059306	54
7	.817958	2.42	.877010	1.85	.940949	4.25	.059051	53
8	.818103	2.40	.876899	1.83	.941204	4.25	.058796	52
9	.818247	2.42	.876789	1.85	.941459	4.23	.058541	51
10	9.818392	2.40	9.876678	1.83	9.941713	4.25	0.058287	50
11	.818536	2.42	.876568	1.85	.941968	4.25	.058032	49
12	.818681	2.40	.876457	1.83	.942223	4.25	.057777	48
13	.818825	2.40	.876347	1.85	.942478	4.25	.057522	47
14	.818969	2.40	.876236	1.85	.942733	4.25	.057267	46
15	9.819113	2.40	9.876125	1.85	9.942988	4.25	0.057012	45
16	819257	2.40	.876014	1.83	.943243	4.25	.056757	44
17	.819401	2.40	.875904	1.85	.943498	4.23	.056502	43
18	.819545	2.40	.875793	1.85	.943752	4.25	.056248	42
19	.819689	2.38	.875682	1.85	.944007	4.25	.055993	41
20	9.819832	2.40	9.875571	1.87	9.944262	4.25	0.055738	40
21	.819976	2.40	.875459	1.85	.944517	4.23	.055483	39
22	.820120	2.38	.875348	1.85	.944771	4.25	.055229	38
23	.820263	2.38	.875237	1.85	.945026	4.25	.054974	37
24	.820406	2.40	.875126	1.87	.945281	4.23	.054719	36
25	9.820550	2.38	9.875014	1.85	9.945535	4.25	0.054465	35
26	.820693	2.38	.874903	1.87	.945790	4.25	.054210	34
27	.820836	2.38	.874791	1.85	.946045	4.23	.053955	33
28	.820979	2.38	.874680	1.87	.946299	4.25	.053701	32
29	.821122	2.38	.874568	1.87	946554	4.23	.053446	31
30	9.821265	2.37	9.874456	1.87	9.946808	4.25	0.053192	30
31	.821407	2.38	.874344	1.87	.947063	4.25	.052937	29
32	.821550	2.38	.874232	1.85	.947318	4.23	.052682	28
33	.821693	2.37	.874121	1.87	.947572	4.25	.052428	27
34	.821835	2.37	.874009	1.88	.947827	4.23	.052173	26
35	9.821977	2.38	9.873896	1.87	9.948081	4.23	0.051919	25
36	.822120	2.37	.873784	1.87	.948335	4.25	.051665	24
37	.822262	2.37	.873672	1.87	.948590	4.23	.051410	23
38	.822404	2.37	.873560	1.87	.948844	4.25	.051156	22
39	.822546	2.37	.873448	1.88	.949099	4.23	.050901	21
40	9.822688	2.37	9.873335	1.87	9.949353	4.25	0.050647	20
41	.822830	2.37	.873223	1.88	.949608	4.23	.050392	19
42	.822972	2.37	.873110	1.87	.949862	4.23	.050138	18
43	.823114	2.35	.872998	1.88	.950116	4.25	.049884	17
44	.823255	2.37	.872885	1.88	.950371	4.23	.049629	16
45	9.823397	2.37	9.872772	1.88	9.950625	4.23	0.049375	15
46	.823539	2.35	.872659	1.87	.950879	4.23	.049121	14
47	.823680	2.35	.872547	1.88	.951133	4.25	.048867	13
48	.823821	2.37	.872434	1.88	.951388	4.23	.048612	12
49	.823963	2.35	.872321	1.88	.951642	4.23	.048358	11
50	9.824104	2.35	9.872208	1.88	9.951896	4.23	0.048104	10
51	.824245	2.35	.872095	1.90	.952150	4.25	.047850	9
52	.824386	2.35	.871981	1.88	.952405	4.23	.047595	8
53	.824527	2.35	.871868	1.88	.952659	4.23	.047341	7
54	.824668	2.33	.871755	1.90	.952913	4.23	.047087	6
55	9.824808	2.35	9.871641	1.88	9.953167	4.23	0.046833	5
56	.824949	2.35	.871528	1.90	.953421	4.23	.046579	4
57	.825090	2.33	.871414	1.88	.953675	4.23	.046325	3
58	.825230	2.35	.871301	1.90	.953929	4.23	.046071	2
59	.825371	2.33	.871187	1.90	.954183	4.23	.045817	1
60	9.825511		9.871073		9.954437		0.045563	0
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D 1".	Tan.	M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.825511	2.33	9.871073	1.88	9.954437	4.23	0.045563	60
1	.825651	2.33	.870960	1.90	.954691	4.25	.045309	59
2	.825791	2.33	.870846	1.90	.954946	4.23	.045054	58
3	.825931	2.33	.870732	1.90	.955200	4.23	.044800	57
4	.826071	2.33	.870618	1.90	.955454	4.23	.044546	56
5	9.826211	2.33	9.870504	1.90	9.955708	4.22	0.044292	55
6	.826351	2.33	.870390	1.90	.955961	4.23	.044039	54
7	.826491	2.33	.870276	1.92	.956215	4.23	.043785	53
8	.826631	2.32	.870161	1.90	.956469	4.23	.043531	52
9	.826770	2.33	.870047	1.90	.956723	4.23	.043277	51
10	9.8[illegible]10	2.32	9.[illegible]33	1.92	9.956977	4.23	0.043023	50
11	.8[illegible]49	2.33	.[illegible]18	1.90	.957231	4.23	.042769	49
12	.8[illegible]89	2.32	.[illegible]04	1.92	.957485	4.23	.042515	48
13	.8[illegible]28	2.32	.[illegible]89	1.92	.957739	4.23	.042261	47
14	.8[illegible]67	2.32	.[illegible]74	1.90	.957993	4.23	.042007	46
15	9.8[illegible]06	2.32	9.[illegible]60	1.92	9.958247	4.22	0.041753	45
16	.8[illegible]45	2.32	.[illegible]45	1.92	.958500	4.23	.041500	44
17	.8[illegible]84	2.32	.[illegible]30	1.92	.958754	4.23	.041246	[illegible]
18	.8[illegible]23	2.32	.[illegible]15	1.92	.959008	4.23	.040992	42
19	.8[illegible]62	2.32	.[illegible]00	1.92	.959262	4.23	.040738	41
20	9.828301	2.30	9.[illegible]85	1.92	9.959516	4.22	0.040484	40
21	.828439	2.32	.[illegible]70	1.92	.959769	4.23	.040231	39
22	.828578	2.30	.[illegible]55	1.92	.960023	4.23	.039977	38
23	.828716	2.32	.[illegible]40	1.93	.960277	4.22	.039723	37
24	.828855	2.30	.[illegible]24	1.92	.960530	4.23	.039470	36
[illegible]	9.828993	2.30	9.[illegible]09	1.93	9.960784	4.23	0.039216	35
[illegible]	.829131	2.30	.[illegible]93	1.92	.961038	4.23	.038962	34
27	.829269	2.30	.[illegible]78	1.93	.961292	4.22	.038708	33
28	.829407	2.30	.[illegible]762	1.92	.961545	4.23	.038455	32
29	.829545	2.30	.867747	1.93	.961799	4.22	.038201	31
30	9.829683	2.30	9.867631	1.93	9.962052	4.23	0.037948	30
31	.829821	2.30	.867515	1.93	.962306	4.23	.037694	29
32	.829959	2.30	.867399	1.93	.962560	4.22	.037440	28
33	.830097	2.28	.867283	1.93	.962813	4.23	.037187	27
34	.830234	2.30	.867167	1.93	.963067	4.22	.036933	26
35	9.830372	2.28	9.867051	1.93	9.963320	4.23	[illegible].036680	25
36	.830509	2.28	.866935	1.93	.963574	4.23	.036426	24
37	.830646	2.30	.866819	1.93	.963828	4.22	.036172	23
38	.830784	2.28	.866703	1.95	.964081	4.23	.035919	22
39	.830921	2.28	.866586	1.93	.964335	4.22	.035665	21
40	9.831058	2.28	9.866470	1.95	9.964588	4.23	0.035412	20
41	.831195	2.28	.866353	1.93	.964842	4.22	.035158	19
42	.831332	2.28	.866237	1.95	.965095	4.23	.034905	18
43	.831469	2.28	.866120	1.93	.965349	4.22	.034651	17
44	.831606	2.27	.866004	1.95	.965602	4.22	.034398	16
45	9.831742	2.28	9.865887	1.95	9.965855	4.23	0.034145	15
46	.831879	2.27	.865770	1.95	.966109	4.22	.033891	14
47	.832015	2.28	.865653	1.95	.966362	4.23	.033638	13
48	.832152	2.27	.865536	1.95	.966616	4.22	.033384	12
49	.832288	2.28	.865419	1.95	.966869	4.23	.033131	11
50	9.832425	2.27	9.865302	1.95	9.967123	4.22	0.032877	10
51	.832561	2.27	.865185	1.95	.967376	4.22	.032624	9
52	.832697	2.27	.865068	1.97	.967629	4.23	.032371	8
53	.832833	2.27	.864950	1.95	.967883	4.22	.032117	7
54	.832969	2.27	.864833	1.95	.968136	4.22	.031864	6
55	9.833105	2.27	9.864716	1.97	9.968389	4.23	0.031611	5
56	.833241	2.27	.864598	1.95	.968643	4.22	.031357	4
57	.833377	2.25	.864481	1.97	.968896	4.22	.031104	3
58	.833512	2.27	.864363	1.97	.969149	4.23	.030851	2
59	.833648	2.25	.864245	1.97	.969403	4.22	.030597	1
60	9.833783		9.864127		9.969656		0.030344	0
								M.

M.	Sin.	D. 1″.	Cos.	D. 1″.	Tan.	D. 1″.	Cot.	
0	9.833783	2.27	9.864127	1.95	9.969656	4.22	0.030344	60
1	.833919	2.25	.864010	1.97	.969909	4.22	.030091	59
2	.834054	2.25	.863892	1.97	.970162	4.23	.029838	58
3	.834189	2.27	.863774	1.97	.970416	4.22	.029584	57
4	.834325	2.25	.863656	1.97	.970669	4.22	.029331	56
5	9.834460	2.25	9.863538	1.98	9.970922	4.22	0.029078	55
6	.834595	2.25	.863419	1.97	.971175	4.23	.028825	54
7	.834730	2.25	.863301	1.97	.971429	4.22	.028571	53
8	.834865	2.23	.863183	1.98	.971682	4.22	.028318	52
9	.834999	2.25	.863064	1.97	.971935	4.22	.028065	51
10	9.835134	2.25	9.862946	1.98	9.972188	4.22	0.027812	50
11	.835269	2.23	.862827	1.97	.972441	4.23	.027559	49
12	.835403	2.25	.862709	1.98	.972695	4.22	.027305	48
13	.835538	2.23	.862590	1.98	.972948	4.22	.027052	47
14	.835672	2.25	.862471	1.97	.973201	4.22	.026799	46
15	9.835807	2.23	9.862353	1.98	9.973454	4.22	0.026546	45
16	.835941	2.23	.862234	1.98	.973707	4.22	.026293	44
17	.836075	2.23	.862115	1.98	.973960	4.22	.026040	43
18	.836209	2.23	.861996	1.98	.974213	4.22	.025787	42
19	.836343	2.23	.861877	1.98	.974466	4.23	.025534	41
20	9.836477	2.23	9.861758	2.00	9.974720	4.22	0.025280	40
21	.836611	2.23	.861638	1.98	.974973	4.22	.025027	39
22	.836745	2.22	.861519	1.98	.975226	4.22	.024774	38
23	.836878	2.23	.861400	2.00	.975479	4.22	.024521	37
24	.837012	2.23	.861280	1.98	.975732	4.22	.024268	36
25	9.837146	2.22	9.861161	2.00	9.975985	4.22	0.024015	35
26	.837279	2.22	.861041	1.98	.976238	4.22	.023762	34
27	.837412	2.23	.860922	2.00	.976491	4.22	.023509	33
28	.837546	2.22	.860802	2.00	.976744	4.22	.023256	32
29	.837679	2.22	.860682	2.00	.976997	4.22	.023003	31
30	9.837812	2.22	9.860562	2.00	9.977250	4.22	0.022750	30
31	.837945	2.22	.860442	2.00	.977503	4.22	.022497	29
32	.838078	2.22	.860322	2.00	.977756	4.22	.022244	28
33	.838211	2.22	.860202	2.00	.978009	4.22	.021991	27
34	.838344	2.22	.860082	2.00	.978262	4.22	.021738	26
35	9.838477	2.22	9.859962	2.00	9.978515	4.22	0.021485	25
36	.838610	2.20	.859842	2.02	.978768	4.22	.021232	24
37	.838742	2.22	.859721	2.00	.979021	4.22	.020979	23
38	.838875	2.20	.859601	2.02	.979274	4.22	.020726	22
39	.839007	2.22	.859480	2.00	.979527	4.22	.020473	21
40	9.839140	2.20	9.859360	2.02	9.979780	4.22	0.020220	20
41	.839272	2.20	.859239	2.00	.980033	4.22	.019967	19
42	.839404	2.20	.859119	2.02	.980286	4.20	.019714	18
43	.839536	2.20	.858998	2.02	.980538	4.22	.019462	17
44	.839668	2.20	.858877	2.02	.980791	4.22	.019209	16
45	9.839800	2.20	9.858756	2.02	9.981044	4.22	0.018956	15
46	.839932	2.20	.858635	2.02	.981297	4.22	.018703	14
47	.840064	2.20	.858514	2.02	.981550	4.22	.018450	13
48	.840196	2.20	858393	2.02	.981803	4.22	.018197	12
49	.840328	2.18	.858272	2.02	.982056	4.22	.017944	11
50	9.840459	2.20	9.858151	2.03	9. 09	4.22	0.017691	10
51	.840591	2.18	.858029	2.02	. 62	4.20	.017438	9
52	.840722	2.20	.857908	2.03	. 14	4.22	.017186	8
53	.840854	2.18	.857786	2.02	. 67	4.22	.016933	7
54	.840985	2.18	.857665	2.03	. 20	4.22	.016680	6
55	9.841116	2.18	9.857543	2.02	9. 73	4.22	0.016427	5
56	841247	2.18	.857422	2.03	. 26	4.22	.016174	4
57	.841378	2.18	.857300	2.03	. 79	4.22	.015921	3
58	.841509	2.18	.857178	2.03	. 32	4.20	.015668	2
59	.841640	2.18	.857056	2.03	. 84	4.22	.015416	1
60	9.841771		9.856934		9. 37		0.015163	0
	Cos.	D. 1″.	Sin.	D. 1″	Cot.	D. 1″.	Tan.	M.

M.	Sin.	D. 1".	Cos.	D. 1".	Tan.	D. 1".	Cot.
0	9.[illegible]71	2.18	9.856934	2.03	9.[illegible]37	4.22	0.015163
1	.[illegible]02	2.18	.856812	2.03	.[illegible]90	4.22	.014910
2	.[illegible]33	2.17	.856690	2.03	.[illegible]43	4.22	.014657
3	.[illegible]63	2.18	.856568	2.03	.[illegible]96	4.20	.014404
4	.[illegible]94	2.17	.856446	2.05	.[illegible]48	4.22	.014152
5	9.[illegible]24	2.18	9.856323	2.03	9.[illegible]01	4.22	0.013899
6	.[illegible]55	2.17	.856201	2.05	.[illegible]54	4.22	.013646
7	.[illegible]85	2.17	.856078	2.03	.[illegible]07	4.22	.013393
8	.[illegible]15	2.18	.855956	2.05	.[illegible]60	4.20	.013140
9	.[illegible]46	2.17	.855833	2.03	.[illegible]12	4.22	.012888
10	9.[illegible]76	2.17	9.855711	2.05	9.[illegible]65	4.22	0.012635
11	.[illegible]06	2.17	.855588	2.05	.[illegible]18	4.22	.012382
12	.[illegible]36	2.17	.855465	2.05	.[illegible]71	4.20	.012129
13	.[illegible]66	2.15	.855342	2.05	.[illegible]23	4.22	.011877
14	.[illegible]95	2.17	.855219	2.05	.[illegible]76	4.22	.011624
15	9.[illegible]25	2.17	9.855096	2.05	9.[illegible]29	4.22	0.011371
16	.[illegible]55	2.15	.854973	2.05	.[illegible]82	4.20	.011118
17	.[illegible]84	2.17	.854850	2.05	.[illegible]34	4.22	.010866
18	.[illegible]14	2.15	.854727	2.07	.[illegible]87	4.22	.010613
19	.[illegible]43	2.15	.854603	2.05	.[illegible]40	4.22	.010360
20	9.[illegible]72	2.17	9.854480	2.07	9.989893	4.20	0.010107
21	.[illegible]02	2.15	.854356	2.05	990145	4.22	.009855
22	.[illegible]31	2.15	.854233	2.07	.990398	4.22	.009602
23	.[illegible]60	2.15	.854109	2.05	.990651	4.20	.009349
24	.[illegible]89	2.15	.853986	2.07	.990903	4.22	.009097
25	9.[illegible]18	2.15	9.853862	2.07	9.991156	4.22	0.008844
26	.[illegible]47	2.15	.853738	2.07	.991409	4.22	.008591
27	.[illegible]76	2.15	.853614	2.07	.991662	4.20	.008338
28	.[illegible]05	2.13	.853490	2.07	991914	4.22	.008086
29	.[illegible]33	2.15	.853366	2.07	.992167	4.22	.007833
30	9.[illegible]62	2.13	9.853242	2.07	9.992420	4.20	0.007580
31	.[illegible]90	2.15	.853118	2.07	992672	4.22	.007328
32	.[illegible]19	2.13	.852994	2.08	.992925	4.22	.007075
33	.[illegible]47	2.13	.852869	2.07	.993178	4.22	.006822
34	.[illegible]75	2.15	.852745	2.08	.993431	4.20	.006569
35	9.[illegible]04	2.13	9.852620	2.07	9.993683	4.22	0.006317
36	.[illegible]32	2.13	.852496	2.08	.993936	4.22	.006064
37	[illegible]60	2.13	.852371	2.07	.994189	4.20	.005811
38	.[illegible]88	2.13	.852247	2.08	.994441	4.22	.005559
39	.[illegible]16	2.13	.852122	2.08	.994694	4.22	.005306
40	9.[illegible]4	2.12	9.851997	2.08	9.994947	4.20	0.005053
41	.[illegible]1	2.13	.851872	2.08	.995199	4.22	.004801
42	.[illegible]9	2.13	.851747	2.08	.995452	4.22	.004548
43	[illegible]7	2.12	.851622	2.08	.995705	4.20	.004295
44	.[illegible]4	2.13	.851497	2.08	.995957	4.22	.004043
45	9.[illegible]2	2.12	9.851372	2.10	9.996210	4.22	0.003790
46	.[illegible]9	2.12	.851246	2.08	.996463	4.20	.003537
47	.[illegible]6	2.13	.851121	2.08	.996715	4.22	.003285
48	.[illegible]4	2.12	.850996	2.10	.996968	4.22	.003032
49	.[illegible]1	2.12	.850870	2.08	.997221	4.20	.002779
50	9.[illegible]8	2.12	9.850745	2.10	9.997473	4.22	0.002527
51	.[illegible]15	2.12	.850619	2.10	.997726	4.22	.002274
52	.[illegible]72	2.12	.850493	2.08	.997979	4.20	.002021
53	.[illegible]9	2.12	.850368	2.10	.998231	4.22	.001769
54	.[illegible]6	2.10	.850242	2.10	.998484	4.22	.001516
55	9.[illegible]52	2.12	9.850116	2.10	9.998737	4.20	0.001263
56	.[illegible]79	2.12	.849990	2.10	.998989	4.22	.001011
57	.[illegible]06	2.10	.849864	2.10	.999242	4.22	.000758
58	.[illegible]32	2.12	.849738	2.12	.999495	4.20	.000505
59	.[illegible]59	2.10	.849611	2.10	.999747	4.22	.000253
60	9.[illegible]85		9.849485		0.000000		0.000000
	Cos.	D. 1".	Sin.	D. 1".	Cot.	D. 1".	Tan.

134°

	0°			1°			2°			
M.	S.	Sin.	Tan.	S.	Sin.	Tan.	S.	Sin.	Tan.	M.
		4.68			4.68			4.68		
0	0	5575	5575	3600	5553	5619	7200	5487	5751	0
1	60	5575	5575	3660	5552	5620	7260	5485	5754	1
2	120	5575	5575	3720	5551	5622	7320	5484	5757	2
3	180	5575	5575	3780	5551	5623	7380	5482	5760	3
4	240	5575	5575	3840	5550	5625	7440	5481	5763	4
5	300	5575	5575	3900	5549	5627	7500	5479	5766	5
6	360	5575	5575	3960	5548	5628	7560	5478	5769	6
7	420	5575	5575	4020	5547	5630	7620	5476	5773	7
8	480	5574	5576	4080	5547	5632	7680	5475	5776	8
9	540	5574	5576	4140	5546	5633	7740	5473	5779	9
10	600	5574	5576	4200	5545	5635	7800	5471	5782	10
11	660	5574	5576	4260	5544	5637	7860	5470	5785	11
12	720	5574	5577	4320	5543	5638	7920	5468	5788	12
13	780	5574	5577	4380	5542	5640	7980	5467	5792	13
14	840	5574	5577	4440	5541	5642	8040	5465	5795	14
15	900	5573	5578	4500	5540	5644	8100	5463	5798	15
16	960	5573	5578	4560	5539	5646	8160	5462	5802	16
17	1020	5573	5578	4620	5539	5648	8220	5460	5805	17
18	1080	5573	5579	4680	5538	5649	8280	5458	5808	18
19	1140	5573	5579	4740	5537	5651	8340	5457	5812	19
20	1200	5572	5580	4800	5536	5653	8400	5455	5815	20
21	1260	5572	5580	4860	5535	5655	8460	5453	5818	21
22	1320	5572	5581	4920	5534	5657	8520	5451	5822	22
23	1380	5572	5581	4980	5533	5659	8580	5450	5825	23
24	1440	5571	5582	5040	5532	5661	8640	5448	5829	24
25	1500	5571	5583	5100	5531	5663	8700	5446	5833	25
26	1560	5571	5583	5160	5530	5665	8760	5444	5836	26
27	1620	5570	5584	5220	5529	5668	8820	5443	5840	27
28	1680	5570	5584	5280	5527	5670	8880	5441	5843	28
29	1740	5570	5585	5340	5526	5672	8940	5439	5847	29
30	1800	5569	5586	5400	5525	5674	9000	5437	5851	30
31	1860	5569	5587	5460	5524	5676	9060	5435	5854	31
32	1920	5569	5587	5520	5523	5679	9120	5433	5858	32
33	1980	5568	5588	5580	5522	5681	9180	5431	5862	33
34	2040	5568	5589	5640	5521	5683	9240	5430	5866	34
35	2100	5567	5590	5700	5520	5685	9300	5428	5869	35
36	2160	5567	5591	5760	5518	5688	9360	5426	5873	36
37	2220	5566	5592	5820	5517	5690	9420	5424	5877	37
38	2280	5566	5593	5880	5516	5693	9480	5422	5881	38
39	2340	5566	5593	5940	5515	5695	9540	5420	5885	39
40	2400	5565	5594	6000	5514	5697	9600	5418	5889	40
41	2460	5565	5595	6060	5512	5700	9660	5416	5893	41
42	2520	5564	5596	6120	5511	5702	9720	5414	5897	42
43	2580	5564	5598	6180	5510	5705	9780	5412	5900	43
44	2640	5563	5599	6240	5509	5707	9840	5410	5905	44
45	2700	5562	5600	6300	5507	5710	9900	5408	5909	45
46	2760	5562	5601	6360	5506	5713	9960	5406	5913	46
47	2820	5561	5602	6420	5505	5715	10020	5404	5917	47
48	2880	5561	5603	6480	5503	5718	10080	5402	5921	48
49	2940	5560	5604	6540	5502	5720	10140	5400	5925	[illegible]
50	3000	5560	5605	6600	5501	5723	10200	5398	5929	50
51	3060	5559	5607	6660	5499	5726	10260	5396	5933	51
52	3120	5558	5608	6720	5498	5729	10320	5394	5937	52
53	3180	6558	5609	6780	5497	5731	10380	5392	5942	53
54	3240	5557	5611	6840	5495	5734	10440	5389	5946	54
55	3300	5556	5612	6900	5494	5737	10500	5387	5950	55
56	3360	5556	5613	6960	5492	5740	10560	5385	5955	56
57	3420	5555	5615	7020	5491	5743	10620	5383	5959	57
58	3480	5554	5616	7080	5490	5745	10680	5381	5963	58
59	3540	5554	5618	7140	5488	5748	10740	5379	5968	59
60	3600	5553	5619	7200	5487	5751	10800	5376	5972	60

.	Tan.	S.	Sin.	Tan.	M.
4.68					
2	6281	18000	5024	6679	0
9	6287	18060	5020	6687	1
6	6293	18120	5016	6694	2
3	6299	18180	5012	6702	3
0	6305	18240	5009	6709	4
7	6311	18300	5005	6716	5
4	6317	18360	5001	6724	6
1	6323	18420	4997	6732	7
8	6329	18480	4994	6739	8
5	6335	18540	4990	6747	9
2	6341	18600	4986	6754	10
9	6348	18660	4982	6762	11
5	6354	18720	4978	6770	12
3	6360	18780	4975	6777	13
0	6366	18840	4971	6785	14
7	6372	18900	4967	6793	15
3	6379	18960	4963	6800	16
0	6385	19020	4959	6808	17
7	6391	19080	4955	6816	18
4	6398	19140	4951	6824	19
1	6404	19200	4948	6832	20
9	6410	19260	4944	6840	21
4	6417	19320	4940	6848	22
1	6423	19380	4936	6855	23
8	6430	19440	4932	6863	24
5	6436	19500	4928	6871	25
1	6443	19560	4924	6879	26
8	6449	19620	4920	6887	27
5	6456	19680	4916	6896	28
2	6463	19740	4912	6904	29
8	6469	19800	4908	6912	30
5	6476	19860	4904	6920	31
2	6482	19920	4900	6928	32
8	6489	19980	4895	6936	33
5	6496	20040	4891	6944	34
2	6503	20100	4887	6953	35
8	6509	20160	4883	6961	36
5	6516	20220	4880	6969	37
1	6523	20280	4875	6977	38
8	6530	20340	4871	6986	39
5	6537	20400	4867	6994	40
1	6544	20460	4862	7003	41
8	6551	20520	4858	7011	42
4	6557	20580	4854	7019	43
1	6564	20640	4850	7028	44
7	6571	20700	4846	7036	45
4	6578	20760	4841	7045	46
0	6585	20820	4837	7053	47
7	6593	20880	4833	7062	48
3	6600	20940	4829	7070	49
0	6607	21000	4824	7079	50
5	6614	21060	4820	7088	51
3	6621	21120	4816	7096	52
9	6628	21180	4811	7105	53
5	6635	21240	4807	7114	54
2	6643	21300	4803	7122	55
8	6650	21360	4798	7131	56
4	6657	21420	4794	7140	57
1	6665	21480	[illegible]	7149	58
7	6672	21540	4785	7158	59
4	6679	21600	4781	7166	60
.	Tan.	S.	Sin.	Tan.	M.

″.

0	6.784741	120.12	6. 05	120.20	0	7.136868	80.18	7.137464	80.28
1	.791948	119.13	. 17	119.22	1	.141679	79.75	.142281	79.85
2	.799096	118.17	. 70	118.25	2	.146464	79.30	.147072	79.42
3	.806186	117.22	. 64	117.28	3	.151222	78.87	.151837	79.00
4	.813219	116.25	. 01	116.35	4	.155954	78.45	.156577	78.55
5	6.820194	115.35	6. 82	115.40	5	7.160661	78.02	7.161290	78.13
6	.827115	114.42	. 06	114.52	6	.165342	77.60	.165978	77.72
7	.833980	113.53	. 77	113.60	7	.169998	77.20	.170641	77.30
8	.840792	112.65	. 93	112.73	8	.174630	76.77	.175279	76.90
9	.847551	111.77	. 57	111.85	9	.179236	76.38	.179893	76.50
10	57	110.92	6. 68	111.00	10	7.183819	75.97	7.184483	76.08
11	12	110.08	. 28	110.15	11	.188377	75.58	.189048	75.68
12	17	109.23	. 37	109.37	12	.192912	75.18	.193589	75.32
13	71	108.43	. 96	108.52	13	.197423	74.78	.198106	74.90
14	77	107.62	. 07	107.70	14	.201910	74.42	.202602	74.53
15	34	106.82	6. 69	106.90	15	7.206375	74.03	7.207074	74.15
16	43	106.05	. 83	106.13	16	.210817	73.65	.211523	73.77
17	08	105.27	. 51	105.35	17	.215236	73.28	.215949	73.40
18	22	104.52	. 72	104.60	18	.219633	72.90	.220353	73.03
19	93	103.75	. 48	103.85	19	.224007	72.55	.224735	72.67
20	6.918618	103.03	6.918979	103.10	20	7.228360	72.18	7.229095	72.30
21	.924800	102.28	.925165	102.38	21	.232691	71.82	.233433	71.95
22	.930937	101.58	.931308	101.67	22	.237000	71.47	.237750	71.60
23	.937032	100.87	.937408	100.95	23	.241288	71.12	.242046	71.25
24	.943084	100.17	.943465	100.25	24	.245555	70.77	.246320	70.90
25	6.949094	99.48	6.949480	99.57	25	7.249801	70.43	7.250574	70.55
26	.955063	98.80	.955454	98.90	26	.254027	70.08	.254807	70.20
27	.960991	98.13	.961388	98.22	27	.258232	69.73	.259019	69.88
28	.966879	97.47	.967281	97.57	28	.262416	69.42	.263212	69.53
29	.972727	96.82	.973135	96.90	29	.266581	69.08	.267384	69.22
30	6.978536	96.17	6.978949	96.27	30	7.270726	68.75	7.271537	68.87
31	.984306	95.55	.984725	95.63	31	.274851	68.42	.275669	68.57
32	.990039	94.90	.990463	95.02	32	.278956	68.12	.279783	68.23
33	.995733	94.30	.996164	94.38	33	.283043	67.78	.283877	67.92
34	7.001391	93.68	7.001827	93.78	34	.287110	67.47	.287952	67.58
35	7.007012	93.08	7.007454	93.17	35	7.291158	67.15	7.292007	67.30
36	.012597	92.48	.013044	92.58	36	.295187	66.83	.296045	66.97
37	.018146	91.90	.018599	92.00	37	.299197	66.55	.300063	66.67
38	.023660	91.32	.024119	91.42	38	.303190	66.23	.304063	66.37
39	.029139	90.75	.029604	90.83	39	.307164	65.92	.308045	66.07
40	7.034584	90.18	7.035054	90.28	40	7.311119	65.63	7.312009	65.77
41	.039995	89.62	.040471	89.72	41	.315057	65.33	.315955	65.47
42	.045372	89.07	.045854	89.17	42	.318977	65.05	.319883	65.18
43	.050716	88.53	.051204	88.63	43	.322880	64.75	.323794	64.88
44	.056028	87.98	.056522	88.08	44	.326765	64.45	.327687	64.60
45	7.061307	87.45	7.061807	87.57	45	7.330632	64.18	7.331563	64.32
46	.066554	86.93	.067061	87.02	46	.334483	63.88	.335422	64.03
47	.071770	86.40	.072282	86.52	47	.338316	63.62	.339264	63.75
48	.076954	85.90	.077473	86.00	48	.342133	63.33	.343089	63.47
49	.082108	85.40	.082633	85.50	49	.345933	63.05	.346897	63.20
50	7.087232	84.88	7.087763	84.98	50	7.349716	62.78	7.350689	62.92
51	.092325	84.40	.092862	84.50	51	.353483	62.50	.354464	62.65
52	.097389	83.90	.097932	84.02	52	.357233	62.25	.358223	62.38
53	.102423	83.42	.102973	83.53	53	.360968	61.97	.361966	62.12
54	.107428	82.95	.107985	83.05	54	.364686	61.72	.365693	61.85
55	7.112405	82.47	7.112968	82.57	55	7.368389	61.45	7.369404	61.60
56	.117353	82.00	.117922	82.12	56	.372076	61.18	.373100	61.33
57	.122273	81.53	.122849	81.65	57	.375747	60.93	.376780	61.07
58	.127165	81.08	.127748	81.18	58	.379403	60.67	.380444	60.83
59	.132030	80.63	.132619	80.75	59	.383043	60.42	.384094	60.57
60	7.136868		7.137464		60	7.386668		7.387728	

			Exsec.	D. 1".					
0	7.386668	60.17	7.387728	60.32	0	7.580389	48.15	7.5 45	48.33
1	.390278	59.93	.391347	60.07	1	.583278	47.98	.5 45	48.17
2	.393874	59.67	.394951	59.82	2	.586157	47.82	.5 35	48.00
3	.397454	59.43	.398540	59.57	3	.589026	47.67	.5 15	47.87
4	.401020	59.18	.402114	59.33	4	.591886	47.52	.5 87	47.70
5	7.404571	58.93	7.405674	59.10	5	7.594737	47.35	7.5 49	47.53
6	.408107	58.70	.409220	58.85	6	.597578	47.20	.5 01	47.38
7	.411629	58.47	.412751	58.62	7	.600410	47.05	.6 44	47.25
8	.415137	58.23	.416268	58.38	8	.603233	46.90	.6 79	47.08
9	.418631	58.00	.419771	58.15	9	.606047	46.73	.6 04	46.92
10	7.422111	57.77	7.423260	57.92	10	7.608851	46.60	7.6 19	46.78
11	.425577	57.53	.426735	57.70	11	.611647	46.45	.6 26	46.63
12	.429029	57.30	.430197	57.45	12	.614433	46.30	.6 24	46.48
13	.432467	57.08	.433644	57.25	13	.617211	46.15	.6 13	46.35
14	.435892	56.85	.437079	57.00	14	.619980	45.98	.6 94	46.18
15	7.439303	56.63	7.440499	56.80	15	7.622739	45.87	7.6 65	46.05
16	.442701	56.42	.443907	56.57	16	.625491	45.70	.6 28	45.90
17	.446086	56.20	.447301	56.35	17	.628233	45.57	.6 82	45.75
18	.449458	55.97	.450682	56.13	18	.630967	45.42	.6 27	45.62
19	.452816	55.77	.454050	55.92	19	.633692	45.28	.6 64	45.48
20	7.456162	55.55	7.457405	55.72	20	7. 09	45.13	7.638293	45.33
21	. 95	55.33	.460748	55.48	21	. 17	44.98	.641013	45.18
22	. 15	55.12	.464077	55.28	22	. 16	44.87	. 24	45.07
23	. 22	54.92	.467394	55.08	23	. 08	44.72	. 28	44.90
24	. 17	54.70	.470699	54.87	24	. 91	44.57	. 22	44.78
25	7. 99	54.50	7.473991	54.65	25	7. 65	44.45	7. 09	44.65
26	. 69	54.28	.477270	54.47	26	. 33	44.30	. 88	44.50
27	. 26	54.10	.480538	54.25	27	. 90	44.17	. 58	44.37
28	. 72	53.88	.483793	54.05	28	. 40	44.05	. 20	44.23
29	. 05	53.70	.487036	53.85	29	. 85	43.90	. 74	44.12
30	7.488927	53.48	7.490267	53.67	30	7. 17	43.77	7. 21	43.97
31	.492136	53.28	.493487	53.45	31	. 43	43.63	59	43.83
32	.495333	53.10	.496694	53.27	32	. 61	43.50	. 89	43.72
33	.498519	52.90	.499890	53.07	33	. 71	43.38	. 12	43.57
34	.501693	52.72	.503074	52.88	34	. 74	43.23	. 26	43.45
35	7.504856	52.53	7.506247	52.68	35	7. 68	43.12	7 33	43.33
36	.508007	52.33	.509408	52.50	36	. 55	42.98	. 33	43.18
37	.511147	52.13	.512558	52.32	37	. 34	42.87	. 24	43.07
38	.514275	51.95	.515697	52.12	38	. 06	42.73	. 08	42.95
39	.517392	51.77	.518824	51.93	39	. 70	42.60	.688585	42.82
40	7.520498	51.58	7.521940	51.77	40	7.689026	42.48	7.691154	42.68
41	.523593	51.40	.525046	51.57	41	.691575	42.35	.693715	42.57
42	.526677	51.22	.528140	51.38	42	.694116	42.23	.696269	42.43
43	.529750	51.03	.531223	51.22	43	.696650	42.12	.698815	42.33
44	.532812	50.85	.534296	51.02	44	.699177	41.98	.701355	42.20
45	7.535863	50.68	7.537357	50.85	45	7.701696	41.87	7.703887	42.07
46	.538904	50.50	.540408	50.68	46	.704208	41.73	.706411	41.97
47	.541934	50.32	.543449	50.50	47	.706712	41.63	.708929	41.85
48	.544953	50.15	.546479	50.33	48	.709210	41.50	.711439	41.72
49	.547962	49.98	.549499	50.15	49	.711700	41.38	.713942	41.60
50	7.550961	49.80	7.552508	49.98	50	7.714183	41.27	7.716438	41.48
51	.553949	49.63	.555507	49.80	51	.716659	41.15	.718927	41.37
52	.556927	49.47	.558495	49.65	52	.719128	41.03	.721409	41.25
53	.559895	49.28	.561474	49.47	53	.721590	40.92	.723884	41.13
54	.562852	49.13	.564442	49.32	54	.724045	40.80	.726352	41.02
55	7.565800	48.95	7.567401	49.13	55	7.726493	40.68	7.728813	40.90
56	.568737	48.80	.570349	48.98	56	.728934	40.57	.731267	40.78
57	.571665	48.63	.573288	48.82	57	.731368	40.47	.733714	40.68
58	.574583	48.47	.576217	48.65	58	.733796	40.33	.736155	40.57
59	.577491	48.30	.579136	48.48	59	.736216	40.23	.738589	40.45
60	7.580389		7.582045		60	7.738630		7.741016	

6°

		″.	Exsec.	D. 1″.
0	7.738630	40.13	7.741016	40.33
1	.741038	40.00	.743436	40.23
2	.743438	39.90	.745850	40.13
3	.745832	39.78	.748258	40.00
4	.748219	39.68	750658	39.90
5	7 750600	39.57	7 753052	39.80
6	.752974	39.47	.755440	39.68
7	.755342	39.35	.757821	39.58
8	.757703	39.25	.760196	39.48
9	.760058	39.13	.762565	39.37
10	7 762406	39.05	7 764927	39.25
11	.764749	38.92	.767282	39.17
12	.767084	38.83	.769632	39.05
13	.769414	38.72	.771975	38.95
14	.771737	38.62	774312	38.85
15	7 774054	38.52	7 776643	38.75
16	776365	38.42	778968	38.63
17	.778670	38.30	781286	38.55
18	.780968	38.22	.783599	38.43
19	.783261	38.10	.785905	38.35
20	7 785547	38.02	7.788206	38.23
21	.787828	37.90	.790500	38.15
22	.790102	37.82	.792789	38.03
23	.792371	37.70	.795071	37.95
24	.794633	37.62	.797348	37.85
25	7 796890	37.52	7.799619	37.75
26	.799141	37.40	.801884	37.65
27	.801385	37.33	.804143	37.57
28	.803625	37.22	.806397	37.45
29	.805858	37.13	.808644	37.37
30	7 808086	37.03	7 810886	37.28
31	.810308	36.93	.813123	37.17
32	.812524	36.83	.815353	37.08
33	.814734	36.75	.817578	37.00
34	816939	36.67	819798	36.90
35	7 819139	36.55	7 822012	36.80
36	.821332	36.48	.824220	36.72
37	.823521	36.37	826423	36.62
38	.825703	36.28	.828620	36.53
39	.827880	36.20	.830812	36.45
40	7 830052	36.10	7.832999	36.35
41	.832218	36.02	.835180	36.27
42	.834379	35.93	.837356	36.17
43	.836535	35.83	.839526	36.08
44	.838685	35.75	841691	36.00
45	7.840830	35.65	7 843851	35.90
46	.842969	35.58	.846005	35.83
47	.845104	35.48	.848155	35.73
48	.847233	35.40	.850299	35.63
49	.849357	35.30	.852437	35.57
50	7.851475	35.23	7.854571	35.48
51	.853589	35.13	.856700	35.38
52	.855697	35.05	.858823	35.32
53	.857800	34.97	.860942	35.22
54	.859898	34.88	863055	35.13
55	7.861991	34.80	7 865163	35.05
56	864079	34.72	.867266	34.98
57	.866162	34.63	.869365	34.88
58	.868240	34.55	.871458	34.80
59	.870313	34.47	.873546	34.73
60	7.872381		7.875630	

7°

M.	Vers.	D. 1″	[illegible]	″.
0	7 872381	34.38	7 [illegible]130	34.63
1	.874444	34.30	[illegible]08	34.57
2	.876502	34.22	[illegible]82	34.48
3	.878555	34.13	[illegible]151	34.40
4	880603	34.07	[illegible]15	34.32
5	7 882647	33.98	7 [illegible]74	34.25
6	.884686	33.90	[illegible]29	34.15
7	.886720	33.82	[illegible]78	34.08
8	.888749	33.73	[illegible]23	34.02
9	.890773	33.67	[illegible]64	33.92
10	7.892793	33.58	7 896199	33.85
11	894808	33.50	.898230	33.77
12	.896818	33.43	900256	33.70
13	.898824	33.35	.902278	33.62
14	.900825	33.27	.904295	33.53
15	7.902821	33.20	7 906307	33.47
16	.904813	33.12	.908315	33.40
17	.906800	33.05	.910319	33.30
18	908783	32.97	.912317	33.25
19	.910761	32.90	.914312	33.17
20	7 912735	32.82	7 916302	33.08
21	.914704	32.73	.918287	33.02
22	.916668	32.68	.920268	32.95
23	.918629	32.58	.922245	32.87
24	920584	32.53	.924217	32.78
25	7 922536	32.45	7.926184	32.73
26	924483	32.37	.928148	32.65
27	.926425	32.32	.930107	32.58
28	.928364	32.22	.932062	32.50
29	930297	32.17	.934012	32.43
30	7.932227	32.08	7 935958	32.37
31	.934152	32.02	937900	32.30
32	.936073	31.95	.939838	32.23
33	937990	31.88	941772	32.15
34	939903	31.80	943701	32.08
35	7 941811	31.73	7.945626	32.02
36	.943715	31.67	.947547	31.95
37	.945615	31.60	.949464	31.87
38	.947511	31.52	951376	31.82
39	949402	31.47	.953285	31.73
40	7 951290	31.38	7.955189	31.68
41	.953173	31.32	.957090	31.60
42	.955052	31.27	.958986	31.53
43	.956928	31.18	960878	31.48
44	958799	31.12	962767	31.40
45	7.960666	31.05	7 964651	31.33
46	962529	30.98	966531	31.28
47	.964388	30.92	.968408	31.20
48	966243	30.85	970280	31.13
49	.968094	30.78	.972148	31.08
50	7 969941	30.73	7 974013	31.02
51	971785	30.65	.975874	30.93
52	.973624	30.58	.977730	30.88
53	975459	30.53	.979583	30.82
54	977291	30.45	981432	30.75
55	7 979118	30.40	7 983277	30.70
56	980942	30.33	985119	30.63
57	982762	30.27	.986956	30.57
58	984578	30.22	.988790	30.50
59	.986391	30.13	990620	30.43
60	7.988199		7 992446	

0	7.988199	30.08	7.992446	30.38	0	8.090317	26.72	8.095697	27.05
1	.990004	30.02	.994260	30.32	1	.091920	26.68	.097320	27.02
2	.991805	29.95	.996068	30.25	2	.093521	26.63	.098941	26.97
3	.993602	29.88	.997903	30.18	3	.095119	26.58	.100559	26.92
4	.995395	29.83	.999714	30.13	4	.096714	26.52	.102174	26.87
5	7.997185	29.77	8.001522	30.07	5	8.098305	26.48	8.103786	26.82
6	.998971	29.72	.003326	30.00	6	.099894	26.43	.105395	26.77
7	8.000754	29.63	.005126	29.95	7	.101480	26.40	.107001	26.73
8	.002532	29.60	.006923	29.88	8	.103064	26.33	.108605	26.67
9	.004308	29.52	.008716	29.83	9	.104644	26.28	.110205	26.63
10	8.006079	29.47	8.010506	29.77	10	8.[illegible]121	26.25	8.111803	26.58
11	.007847	29.40	.012292	29.70	11	.[illegible]96	26.18	.113398	26.53
12	.009611	29.35	.014074	29.65	12	.[illegible]67	26.15	.114990	26.48
13	.011372	29.28	.015853	29.58	13	.[illegible]36	26.10	.116579	26.45
14	.013129	29.22	.017628	29.53	14	.[illegible]01	26.05	.118166	26.38
15	8.014882	29.17	8.019400	29.47	15	8.[illegible]65	26.00	8.119749	26.35
16	.016632	29.10	.021168	29.42	16	.[illegible]25	25.95	.121330	26.30
17	.018378	29.05	.022933	29.35	17	.[illegible]82	25.92	.122908	26.25
18	.020121	29.00	.024694	29.30	18	.[illegible]37	25.87	.124483	26.22
19	.021861	28.93	.026452	29.23	19	.[illegible]89	25.82	.126056	26.17
20	8.023597	28.87	8.028206	29.18	20	8.121858	25.77	8.127626	26.12
21	.025329	28.82	.029957	29.13	21	.123384	25.72	.129193	26.07
22	.027058	28.75	.031705	29.07	22	.124927	25.68	.130757	26.02
23	.028783	28.70	.033449	29.00	23	.126468	25.63	.132318	25.98
24	.030505	28.65	.035189	28.97	24	.128006	25.58	.133877	25.93
25	8.032224	28.58	8.036927	28.90	25	8.129541	25.55	8.135433	25.90
26	.033939	28.53	.038661	28.83	26	.131074	25.50	.136987	25.85
27	.035651	28.47	.040391	28.78	27	.132604	25.45	.138538	25.80
28	.037359	28.42	.042118	28.73	28	.134131	25.40	.140086	25.75
29	.039064	28.37	.043842	28.68	29	.135655	25.37	.141631	25.72
30	8.040766	28.30	8.045563	28.62	30	8.137177	25.32	8.143174	25.67
31	.042464	28.25	.047280	28.57	31	.138696	25.27	.144714	25.63
32	.044159	28.20	.048994	28.50	32	.140212	25.23	.146252	25.58
33	.045851	28.13	.050704	28.47	33	.141726	25.18	.147787	25.53
34	.047539	28.08	.052412	28.40	34	.143237	25.13	.149319	25.50
35	8.049224	28.03	8.054116	28.35	35	8.144745	25.10	8.150849	25.45
36	.050906	27.98	.055817	28.28	36	.146251	25.05	.152376	25.40
37	.052585	27.92	.057514	28.25	37	.147754	25.02	.153900	25.37
38	.054260	27.87	.059209	28.18	38	.149255	24.95	.155422	25.33
39	.055932	27.82	.060900	28.13	39	.150752	44.93	.156942	25.27
40	8.057601	27.75	8.062588	28.08	40	8.152248	24.88	8.158458	25.25
41	.059266	27.72	.064273	28.03	41	.153741	24.83	.159973	25.18
42	.060929	27.65	.065955	27.97	42	.155231	24.78	.161484	25.17
43	.062588	27.60	.067633	27.93	43	.156718	24.75	.162994	25.10
44	.064244	27.55	.069309	27.87	44	.158203	24.72	.164500	25.07
45	8.065897	27.48	8.070981	27.82	45	8.159686	24.67	8.166004	25.03
46	.067546	27.45	.072650	27.77	46	.161166	24.62	.167506	24.98
47	.069193	27.38	.074316	27.72	47	.162643	24.58	.169005	24.95
48	.070836	27.33	.075979	27.67	48	.164118	24.53	.170502	24.90
49	.072476	27.30	.077639	27.60	49	.165590	24.50	.171996	24.87
50	8.074114	27.23	8.079295	27.57	50	8.167060	24.45	8.173488	24.82
51	.075748	27.18	.080949	27.52	51	.168527	24.42	.174977	24.78
52	.077379	27.13	.082600	27.45	52	.169992	24.37	.176464	24.73
53	.079007	27.07	.084247	27.42	53	.171454	24.33	.177948	24.70
54	.080631	27.03	.085892	27.37	54	.172914	24.30	.179430	24.65
55	8.082253	26.98	8.087534	27.30	55	8.174372	24.25	8.180909	24.62
56	.083872	26.93	.089172	27.27	56	.175827	24.20	.182386	24.58
57	.085488	26.87	.090808	27.20	57	.177279	24.17	.183861	24.53
58	.087100	26.83	.092440	27.17	58	.178729	24.13	.185333	24.50
59	.088710	26.78	.094070	27.12	59	.180177	24.08	.186803	24.47
60	8.090317		8.095697		60	8.181622		8.188271	

10°					11°				
M.	Vers.	D. 1".	Exsec.	D. 1".	M.	Vers.	D. 1".	Exsec.	D. 1".
0	8.181622	24.05	8.188271	24.42	0	8.264176	21.85	8.272229	22.27
1	.183065	24.00	.189736	24.37	1	.265487	21.82	.273565	22.22
2	.184505	23.97	.191198	24.35	2	.266796	21.78	.274898	22.20
3	.185943	23.93	.192659	24.30	3	.268103	21.75	.276230	22.17
4	.187379	23.88	.194117	24.25	4	.269408	21.72	.277560	22.13
5	8.188812	23.85	8.195572	24.22	5	8.270711	21.68	8.278888	22.08
6	.190243	23.80	.197025	24.18	6	.272012	21.65	.280213	22.07
7	.191671	23.77	.198476	24.15	7	.273311	21.62	.281537	22.03
8	.193097	23.73	.199925	24.10	8	.274608	21.58	.282859	22.00
9	.194521	23.68	.201371	24.07	9	.275903	21.57	.284179	21.98
10	8.195942	23.65	8.202815	24.03	10	8.277197	21.52	8.285498	21.93
11	.197361	23.62	.204257	23.98	11	.278488	21.48	.286814	21.90
12	.198778	23.57	.205696	23.95	12	.279777	21.47	.288128	21.88
13	.200192	23.53	.207133	23.92	13	.281065	21.42	.289441	21.83
14	.201604	23.50	.208568	23.88	14	.282350	21.40	.290751	21.82
15	8.203014	23.45	8.210001	23.83	15	8.283634	21.37	8.292060	21.78
16	.204421	23.42	.211431	23.80	16	.284916	21.33	.293367	21.75
17	.205826	23.38	.212859	23.77	17	.286196	21.28	.294672	21.72
18	.207229	23.35	.214285	23.72	18	.287473	21.27	.295975	21.68
19	.208630	23.30	.215708	23.70	19	.288749	21.25	.297276	21.67
20	8.210028	23.27	8.217130	23.65	20	8.290024	21.20	8.298576	21.62
21	.211424	23.23	.218549	23.62	21	.291296	21.17	.299873	21.60
22	.212818	23.18	.219966	23.57	22	.292566	21.15	.301169	21.57
23	.214209	23.17	.221380	23.55	23	.293835	21.10	.302463	21.53
24	.215599	23.12	.222793	23.50	24	.295101	21.08	.303755	21.50
25	8.216986	23.08	8.224203	23.47	25	8.296366	21.05	8.305045	21.48
26	.218371	23.03	.225611	23.43	26	.297629	21.02	.306334	21.43
27	.219753	23.00	.227017	23.40	27	.298890	20.98	.307620	21.42
28	.221133	22.98	.228421	23.35	28	.300149	20.95	.308905	21.38
29	.222512	22.93	.229822	23.32	29	.301406	20.93	.310188	21.35
30	8.223888	22.88	8.231221	23.30	30	8.302662	20.90	8.311469	21.33
31	.225261	22.87	.232619	23.25	31	.303916	20.85	.312749	21.28
32	.226633	22.82	.234014	23.22	32	.305167	20.85	.314026	21.27
33	.228002	22.78	.235407	23.17	33	.306418	20.80	.315302	21.23
34	.229369	22.77	.236797	23.15	34	.307666	20.77	.316576	21.20
35	8.230735	22.70	8.238186	23.10	35	8.308912	20.75	8.317848	21.18
36	.232097	22.68	.239572	23.08	36	.310157	20.72	.319119	21.15
37	.233458	22.65	.240957	23.03	37	.311400	20.68	.320388	21.12
38	.234817	22.60	.242339	23.00	38	.312641	20.65	.321655	21.08
39	.236173	22.57	.243719	22.97	39	.313880	20.62	.322920	21.05
40	8.237527	22.55	8.245097	22.93	40	8.315117	20.60	8.324183	21.03
41	.238880	22.50	.246473	22.90	41	.316353	20.57	.325445	21.00
42	.240230	22.47	.247847	22.87	42	.317587	20.53	.326705	20.98
43	.241578	22.43	.249219	22.83	43	.318819	20.50	.327964	20.93
44	.242924	22.38	.250589	22.80	44	.320049	20.48	.329220	20.92
45	8.244267	22.37	8.251957	22.75	45	8.321278	20.45	8.330475	20.88
46	.245609	22.32	.253322	22.73	46	.322505	20.42	.331728	20.87
47	.246948	22.30	.254686	22.68	47	.323730	20.38	.332980	20.82
48	.248286	22.25	.256047	22.67	48	.324953	20.37	.334229	20.80
49	.249621	22.23	.257407	22.62	49	.326175	20.33	.335477	20.78
50	8.250955	22.18	8.258764	22.60	50	8.327395	20.30	8.336724	20.73
51	.252286	22.15	.260120	22.55	51	.328613	20.27	.337968	20.72
52	.253615	22.12	.261473	22.53	52	.329829	20.25	.339211	20.70
53	.254942	22.10	.262825	22.48	53	.331044	20.22	.340453	20.65
54	.256268	22.05	.264174	22.47	54	.332257	20.18	.341692	20.63
55	8.257591	22.02	8.265522	22.42	55	8.333468	20.17	8.342930	20.60
56	.258912	21.98	.266867	22.40	56	.334678	20.13	.344166	20.58
57	.260231	21.95	.268211	22.35	57	.335886	20.10	.345401	20.55
58	.261548	21.92	.269552	22.33	58	.337092	20.07	.346634	20.52
59	.262863	21.88	.270892	22.28	59	.338296	20.05	.347865	20.50
60	8.264176		8.272229		60	8.339499		8.349095	

12°									
M.	Vers.	D. 1".	Exsec.	D. 1".	M				
0	8.339499	20.02	8.349095	20.47	0	8.408748	18.47	8.420024	18.95
1	.340700	20.00	.350323	20.43	1	.409856	18.43	.421161	18.93
2	.341900	19.95	.351549	20.42	2	.410962	18.42	.422297	18.90
3	.343097	19.95	.352774	20.38	3	.412067	18.40	.423431	18.88
4	.344294	19.90	.353997	20.35	4	.413171	18.38	.424564	18.87
5	8.345488	19.88	8.355218	20.33	5	8.414274	18.35	8.425696	18.83
6	.346681	19.85	.356438	20.30	6	.415375	18.32	.426826	18.82
7	.347872	19.82	.357656	20.28	7	.416474	18.30	.427955	18.80
8	.349061	19.80	.358871	20.25	8	.417572	18.28	.429083	18.77
9	.350249	19.77	.360086	20.22	9	.418669	18.25	.430209	18.75
10	8.351435	19.75	8.361301	20.20	10	8.419764	18.23	8.431334	18.73
11	.352620	19.72	.362513	20.18	11	.420858	18.22	.432458	18.70
12	.353803	19.68	.363724	20.13	12	.421951	18.18	.433580	18.67
13	.354984	19.67	.364932	20.12	13	.423042	18.17	.434700	18.67
14	.356164	19.63	.366139	20.10	14	.424132	18.13	.435820	18.63
15	8.357342	19.60	8.367345	20.07	15	8.425220	18.12	8.436938	18.62
16	.358518	19.58	.368549	20.03	16	.426307	18.10	.438055	18.58
17	.359693	19.55	.369751	20.02	17	.427393	18.07	.439170	18.57
18	.360866	19.53	.370952	19.98	18	.428477	18.05	.440284	18.55
19	.362038	19.50	.372151	19.95	19	.429560	18.03	.441397	18.53
20	8.363208	19.48	8.373348	19.95	20	8.430641	18.02	8.442509	18.50
21	.364377	19.43	[illegible]45	19.90	21	.431722	17.97	.443619	18.47
22	.365543	19.43	.[illegible]39	19.88	22	.432800	17.97	.444727	18.47
23	.366709	19.38	.[illegible]32	19.85	23	.433878	17.93	.445835	18.43
24	.367872	19.37	.[illegible]25	19.83	24	.434954	17.92	.446941	18.42
25	8.369034	19.35	8.[illegible]15	19.82	25	8.436029	17.88	8.448046	18.38
26	.370195	19.32	.[illegible]02	19.78	26	.437102	17.87	.449149	18.38
27	.371354	19.28	.[illegible]89	19.75	27	.438174	17.85	.450252	18.35
28	.372511	19.27	.[illegible]74	19.73	28	.439245	17.82	.451353	18.32
29	.373667	19.25	.[illegible]58	19.70	29	.440314	17.80	.452452	18.32
30	8.374822	19.20	8.385240	19.68	30	8.441382	17.78	8.453551	18.28
31	.375974	19.18	.386421	19.65	31	.442449	17.75	.454648	18.25
32	.377125	19.17	.387600	19.63	32	.443514	17.73	.455743	18.25
33	.378275	19.13	.388778	19.60	33	.444578	17.72	.456838	18.22
34	.379423	19.12	.389954	19.58	34	.445641	17.68	.457931	18.20
35	8.380570	19.08	8.391129	19.55	35	8.446702	17.68	8.459023	18.18
36	.381715	19.05	.392302	19.53	36	.447763	17.63	.460114	18.15
37	.382858	19.03	.393474	19.50	37	.448821	17.63	.461203	18.13
38	.384000	19.02	.394644	19.48	38	.449879	17.60	.462291	18.12
39	.385141	18.98	.395813	19.45	39	.450935	17.58	.463378	18.10
40	8.386280	18.95	8.396980	19.43	40	8.451990	17.55	8.464464	18.07
41	.387417	18.93	.398146	19.42	41	.453043	17.55	.465548	18.05
42	.388553	18.92	.399311	19.38	42	.454096	17.52	.466631	18.03
43	.389688	18.88	.400474	19.35	43	.455147	17.48	.467713	18.00
44	.390821	18.85	.401635	19.33	44	.456196	17.48	.468793	18.00
45	8.391952	18.83	8.402795	19.32	45	8.457245	17.45	8.469873	17.97
46	.393082	18.82	.403954	19.28	46	.458292	17.43	.470951	17.95
47	.394211	18.78	.405111	19.27	47	.459338	17.40	.472028	17.92
48	.395338	18.75	.406267	19.23	48	.460382	17.40	.47[illegible]03	17.90
49	.396463	18.73	.407421	19.22	49	.461426	17.37	.474177	17.90
50	8.397587	18.72	8.408574	19.18	50	8.462468	17.35	8.475251	17.85
51	.398710	18.68	.409725	19.17	51	.463509	17.32	.476322	17.85
52	.399831	18.67	.410875	19.13	52	.464548	17.30	.477393	17.83
53	.400951	18.63	.412023	19.13	53	.465586	17.28	.478463	17.80
54	.402069	18.62	.413171	19.08	54	.466623	17.27	.479531	17.78
55	8.403186	18.58	8.414316	19.08	55	8.467659	17.23	8.480598	17.77
56	.404301	18.57	.415461	19.03	56	.468693	17.23	.481664	17.73
57	.405415	18.53	.416603	19.03	57	.469727	17.20	.482728	17.73
58	.406527	18.52	.417745	19.00	58	.470759	17.17	.483792	17.72
59	.407638	18.50	.418885	18.98	59	.471789	17.17	.484854	17.68
60	8.408748		8.420024		60	8.472819		8.485915	

						15°			
				1".	M.	Vers.	D. 1".	Exsec.	D. 1".
0	8.472819	17.13	8.485915	17.67	0	8.532425	15.98	8.547482	16.53
1	.473847	17.12	.486975	17.63	1	.533384	15.97	.548474	16.53
2	.474874	17.10	.488033	17.63	2	.534342	15.95	.549466	16.52
3	.475900	17.08	.489091	17.60	3	.535299	15.93	.550457	16.50
4	.476925	17.05	.490147	17.58	4	.536255	15.92	.551447	16.48
5	8.477948	17.03	8.491202	17.57	5	8.537210	15.88	8.552436	16.47
6	.478970	17.02	.492256	17.53	6	.538163	15.88	.553424	16.43
7	.479991	17.00	.493308	17.53	7	.539116	15.87	.554410	16.43
8	.481011	16.97	.494360	17.50	8	.540068	15.83	.555396	16.42
9	.482029	16.95	.495410	17.48	9	.541018	15.83	.556381	16.38
10	8.483046	16.93	8.496459	17.47	10	8.541968	15.80	8.557364	16.38
11	.484062	16.92	.497507	17.45	11	.542916	15.78	.558347	16.37
12	.485077	16.90	.498554	17.43	12	.543863	15.78	.559329	16.33
13	.486091	16.87	.499600	17.40	13	.544810	15.75	.560309	16.33
14	.487103	16.87	.500644	17.38	14	.545755	15.73	.561289	16.30
15	8.488115	16.83	8.501687	17.38	15	8.546699	15.72	8.562267	16.30
16	.489125	16.82	.502730	17.35	16	.547642	15.70	.563245	16.28
17	.490134	16.78	.503771	17.32	17	.548584	15.68	.564222	16.25
18	.491141	16.78	.504810	17.32	18	.549525	15.67	.565197	16.25
19	.492148	16.75	.505849	17.30	19	.550465	15.65	.566172	16.22
20	8.493153	16.73	8.506887	17.27	20	8.551404	15.63	8.567145	16.22
21	.494157	16.72	.507923	17.25	21	.552342	15.62	.568118	16.20
22	.495160	16.70	.508958	17.25	22	.553279	15.60	.569090	16.17
23	.496162	16.67	.509993	17.22	23	.554215	15.58	.570060	16.17
24	.497162	16.67	.511026	17.18	24	.555150	15.57	.571030	16.15
25	8.498162	16.63	8.512057	17.18	25	8.556084	15.55	8.571999	16.12
26	.499160	16.62	.513088	17.17	26	.557017	15.53	.572966	16.12
27	.500157	16.60	.514118	17.13	27	.557949	15.50	.573933	16.10
28	.501153	16.58	.515146	17.13	28	.558879	15.50	.574899	16.08
29	.502148	16.57	.516174	17.10	29	.559809	15.48	.575864	16.05
30	8.503142	16.53	8.517200	17.08	30	8.560738	15.47	8.576827	16.05
31	.504134	16.52	.518225	17.07	31	.561666	15.45	.577790	16.03
32	.505125	16.52	.519249	17.05	32	.562593	15.43	.578752	16.02
33	.506116	16.48	.520272	17.03	33	.563518	15.42	.579713	16.00
34	.507105	16.45	.521294	17.02	34	.564443	15.40	.580673	15.98
35	8.508092	16.45	8.522315	16.98	35	8.565367	15.37	8.581632	15.97
36	.509079	16.43	.523334	16.98	36	.566289	15.37	.582590	15.95
37	.510065	16.40	.524353	16.95	37	.567211	15.35	.583547	15.93
38	.511049	16.40	.525370	16.95	38	.568132	15.33	.584503	15.92
39	.512033	16.37	.526387	16.92	39	.569052	15.30	.585458	15.90
40	8.513015	16.35	8.527402	16.90	40	8.569970	15.30	8.586412	15.88
41	.513996	16.33	.528416	16.88	41	.570888	15.28	.587365	15.88
42	.514976	16.32	.529429	16.87	42	.571805	15.27	.588318	15.85
43	.515955	16.28	.530441	16.85	43	.572721	15.25	.589269	15.83
44	.516932	16.28	.531452	16.83	44	.573636	15.22	.590219	15.83
45	8.517909	16.25	8.532462	16.82	45	8.574549	15.22	8.591169	15.80
46	.518884	16.25	.533471	16.78	46	.575462	15.20	.592117	15.80
47	.519859	16.22	.534478	16.78	47	.576374	15.18	.593065	15.78
48	.520832	16.20	.535485	16.75	48	.577285	15.17	.594012	15.75
49	.521804	16.18	.536490	16.73	49	.578195	15.15	.594957	15.75
50	8.522775	16.17	8.537495	16.72	50	8. 04	15.13	8.595902	15.73
51	.523745	16.15	.538498	16.72	51	. 12	15.12	.596846	15.72
52	.524714	16.13	.539501	16.68	52	. 19	15.10	.597789	15.70
53	.525682	16.10	.540502	16.67	53	. 25	15.08	.598731	15.68
54	.526648	16.10	.541502	16.65	54	. 30	15.07	.599672	15.67
55	8.527614	16.07	8.542501	16.63	55	8. 34	15.05	8.600612	15.65
56	.528578	16.07	.543499	16.63	56	. 37	15.05	.601551	15.65
57	.529542	16.03	.544497	16.60	57	. 40	15.02	.602490	15.62
58	.530504	16.02	.545493	16.58	58	. 41	15.00	.603427	15.60
59	.531465	16.00	.546488	16.57	59	. 41	15.00	.604363	15.60
60	8.532425		8.547482		60	8. 41		8.605299	

0	8.588141	14.97	8.605299	15.58	0	8. 34	14.08	8.659838	14.72
1	.589039	14.95	.606234	15.55	1	. 79	14.07	.660721	14.72
2	.589936	14.95	.607167	15.55	2	. 23	14.05	.661604	14.70
3	.590833	14.93	.608100	15.53	3	. 66	14.05	.662486	14.68
4	.591729	14.90	.609032	15.52	4	. 09	14.02	.663367	14.68
5	8.592623	14.90	8.609963	15.50	5	8. 50	14.02	8.664248	14.65
6	.593517	14.88	.610893	15.50	6	. 91	14.00	.665127	14.65
7	.594410	14.87	.611823	15.47	7	. 31	13.98	.666006	14.63
8	.595302	14.83	.612751	15.45	8	. 70	13.97	.666884	14.62
9	.596192	14.83	.613678	15.45	9	. 08	13.95	.667761	14.60
10	8.597082	14.82	8.614605	15.43	10	8. 45	13.95	8.668637	14.60
11	.597971	14.82	.615531	15.42	11	. 82	13.93	.669513	14.58
12	.598860	14.78	.616456	15.38	12	. 18	13.92	.670388	14.57
13	.599747	14.77	.617379	15.38	13	. 53	13.90	.671262	14.55
14	.600633	14.75	.618302	15.38	14	. 87	13.88	.672135	14.55
15	8.601518	14.75	8.619225	15.35	15	8. 20	13.87	8.673008	14.52
16	.602403	14.72	.620146	15.33	16	. 52	13.87	.673879	14.52
17	.603286	14.72	.621066	15.33	17	. 84	13.85	.674750	14.50
18	.604169	14.70	.621986	15.30	18	. 15	13.83	.675620	14.50
19	.605051	14.67	.622904	15.30	19	. 45	13.82	.676490	14.47
20	8.605931	14.67	8.623822	15.28	20	8. 74	13.82	8.677358	14.47
21	.606811	14.65	.624739	15.27	21	. 03	13.78	.678226	14.45
22	.607690	14.63	.625655	15.25	22	. 30	13.78	.679093	14.45
23	.608568	14.62	.626570	15.23	23	. 57	13.77	.679960	14.42
24	.609445	14.60	.627484	15.23	24	. 83	13.75	.680825	14.42
25	8.610321	14.60	8.628398	15.20	25	8. 08	13.73	8.681690	14.40
26	.611197	14.57	.629310	15.20	26	. 32	13.73	.682554	14.38
27	.612071	14.57	.630222	15.18	27	. 56	13.72	.683417	14.38
28	.612945	14.53	.631133	15.17	28	. 79	13.70	.684280	14.35
29	.613817	14.53	.632043	15.15	29	. 01	13.68	.685141	14.35
30	8.614689	14.52	8. 52	15.13	30	8. 22	13.67	8.686002	14.35
31	.615560	14.50	. 60	15.13	31	. 42	13.67	.686863	14.32
32	.616430	14.48	. 68	15.10	32	. 62	13.65	.687722	14.32
33	.617299	14.47	. 74	15.10	33	. 81	13.63	.688581	14.30
34	.618167	14.45	. 80	15.08	34	. 99	13.62	.689439	14.28
35	8.619034	14.45	8. 85	15.07	35	8. 16	13.60	8.690296	14.28
36	.619901	14.42	. 89	15.05	36	. 32	13.60	.691153	14.25
37	.620766	14.42	. 92	15.05	37	. 48	13.58	.692008	14.25
38	.621631	14.40	. 95	15.02	38	. 63	13.57	.692863	14.25
39	.622495	14.38	. 96	15.02	39	. 77	13.55	.693718	14.22
40	8.623358	14.37	8. 97	15.00	40	8. 90	13.55	8.694571	14.22
41	.624220	14.35	. 97	14.98	41	. 03	13.53	.695424	14.20
42	.625081	14.33	. 96	14.97	42	. 15	13.52	.696276	14.18
43	.625941	14.33	. 94	14.95	43	. 26	13.50	.697127	14.18
44	.626801	14.30	. 91	14.95	44	. 36	13.48	.697978	14.17
45	8.627659	14.30	8. 88	14.93	45	8. 45	13.48	8.698828	14.15
46	.628517	14.28	. 84	14.92	46	. 54	13.47	.699677	14.13
47	.629374	14.27	. 79	14.90	47	. 62	13.45	.700525	14.13
48	.630230	14.25	. 73	14.88	48	. 69	13.43	.701373	14.12
49	.631085	14.23	. 66	14.87	49	. 75	13.43	.702230	14.10
50	8. 39	14.22	8. 58	14.87	50	8.681681	13.42	8. 66	14.10
51	. 92	14.22	. 50	14.85	51	.682486	13.40	. 12	14.07
52	. 45	14.18	. 41	14.83	52	.683290	13.38	. 36	14.07
53	. 96	14.18	. 31	14.82	53	.684093	13.38	. 00	14.07
54	. 47	14.17	. 20	14.80	54	.684896	13.35	. 44	14.03
55	8. 97	14.15	8. 08	14.80	55	8.685697	13.35	8. 86	14.03
56	. 46	14.13	. 96	14.77	56	.686498	13.35	. 28	14.02
57	. 94	14.13	. 82	14.77	57	.687299	13.32	. 69	14.02
58	. 42	14.10	. 68	14.77	58	.688098	13.32	. 10	14.00
59	. 88	14.10	. 54	14.73	59	.688897	13.30	. 50	13.98
60	8. 34		8. 38		60	8.689695		8. 89	

′					′	19°			
0	8. 95	13.28	8.711489	13.97	0	8.736248	12.58	8.760578	13.30
1	. 92	13.28	.712327	13.95	1	.737003	12.57	.761376	13.30
2	. 89	13.25	.713164	13.95	2	.737757	12.55	.762174	13.28
3	. 84	13.25	.714001	13.95	3	.738510	12.55	.762971	13.27
4	. 79	13.25	.714838	13.92	4	.739263	12.53	.763767	13.27
5	8. 74	13.22	8.715673	13.92	5	8.740015	12.52	8.764563	13.25
6	. 67	13.22	.716508	13.90	6	.740766	12.50	.765358	13.23
7	. 60	13.20	.717342	13.88	7	.741516	12.50	.766152	13.23
8	. 52	13.18	.718175	13.88	8	.742266	12.50	.766946	13.22
9	. 43	13.18	.719008	13.87	9	.743016	12.47	.767739	13.20
10	8.697634	13.17	8.719840	13.85	10	8.743764	12.47	8.768531	13.20
11	.698424	13.15	.720671	13.85	11	.744512	12.45	.769323	13.18
12	.699213	13.13	.721502	13.83	12	.745259	12.45	.770114	13.18
13	.700001	13.13	.722332	13.82	13	.746006	12.43	.770905	13.17
14	.700789	13.12	.723161	13.80	14	.746752	12.42	.771695	13.15
15	8.701576	13.10	8.723989	13.80	15	8.747497	12.42	8.772484	13.15
16	.702362	13.08	.724817	13.78	16	.748242	12.40	.773273	13.13
17	.703147	13.08	.725644	13.78	17	.748986	12.38	.774061	13.13
18	.703932	13.07	.726471	13.77	18	.749729	12.38	.774849	13.10
19	.704716	13.05	.727297	13.75	19	.750472	12.37	.775635	13.12
20	8.705499	13.05	8.728122	13.73	20	8.751214	12.35	8.776422	13.08
21	.706282	13.02	.728946	13.73	21	.751955	12.35	.777207	13.10
22	.707063	13.02	.729770	13.72	22	.752696	12.33	.777993	13.07
23	.707844	13.02	.730593	13.70	23	.753436	12.32	.778777	13.07
24	.708625	12.98	.731415	13.70	24	.754175	12.32	.779561	13.05
25	8.709404	12.98	8.732237	13.68	25	8.754914	12.30	8.780344	13.05
26	.710183	12.97	.733058	13.67	26	.755652	12.28	.781127	13.03
27	.710961	12.97	.733878	13.67	27	.756389	12.28	.781909	13.02
28	.711739	12.95	.734698	13.65	28	.757126	12.27	.782690	13.02
29	.712516	12.93	.735517	13.63	29	.757862	12.27	.783471	13.00
30	8.713292	12.92	8.736335	13.63	30	8.758598	12.25	8.784251	13.00
31	.714067	12.92	.737153	13.62	31	.759333	12.23	.785031	12.98
32	.714842	12.90	.737970	13.60	32	.760067	12.23	.785810	12.97
33	.715616	12.88	.738786	13.60	33	.760801	12.22	.786588	12.97
34	.716389	12.87	.739602	13.58	34	.761534	12.20	.787366	12.97
35	8.717161	12.87	8.740417	13.57	35	8.762266	12.20	8.788144	12.93
36	.717933	12.85	.741231	13.57	36	.762998	12.18	.788920	12.93
37	.718704	12.85	.742045	13.55	37	.763729	12.17	.789696	12.93
38	.719475	12.82	.742858	13.53	38	.764459	12.17	.790472	12.92
39	.720244	12.82	.743670	13.53	39	.765189	12.15	.791247	12.90
40	8.721013	12.80	8.744482	13.52	40	8.765918	12.15	8.792021	12.90
41	.721782	12.78	.745293	13.50	41	.766647	12.12	.792795	12.88
42	.722549	12.78	.746103	13.50	42	.767374	12.13	.793568	12.87
43	.723316	12.78	.746913	13.48	43	.768102	12.10	.794340	12.87
44	.724083	12.75	.747722	13.47	44	.768828	12.10	.795112	12.87
45	8.724848	12.75	8.748530	13.47	45	8.769554	12.10	8.795884	12.83
46	.725613	12.73	.749338	13.45	46	.770280	12.08	.796654	12.85
47	.726377	12.72	.750145	13.43	47	.771005	12.07	.797425	12.82
48	.727140	12.72	.750951	13.43	48	.771729	12.05	.798194	12.82
49	.727903	12.70	.751757	13.42	49	.772452	12.05	.798963	12.82
50	8.728665	12.70	8.752562	13.42	50	8.773175	12.05	8.799732	12.80
51	.729427	12.67	.753367	13.40	51	.773898	12.02	.800500	12.78
52	.730187	12.67	.754171	13.38	52	.774619	12.02	.801267	12.78
53	.730947	12.67	.754974	13.37	53	.775340	12.02	.802034	12.77
54	.731707	12.63	.755776	13.37	54	.776061	12.00	.802800	12.75
55	8.732465	12.63	8.756578	13.37	55	8.776781	11.98	8.803565	12.75
56	.733223	12.63	.757380	13.33	56	.777500	11.97	.804330	12.75
57	.733981	12.60	.758180	13.33	57	.778218	11.97	.805095	12.73
58	.734737	12.60	.758980	13.33	58	.778936	11.97	.805859	12.72
59	.735493	12.58	.759780	13.30	59	.779654	11.95	.806622	12.72
60	8.736248		8.760578		60	8.780370		8.807385	

20°

M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	8. 780370	11. 95	8. 807385	12. 70
1	. 781087	11. 92	. 808147	12. 68
2	. 781802	11. 92	. 808908	12. 68
3	. 782517	11. 90	. 809669	12. 68
4	. 783231	11. 90	. 810430	12. 67
5	8. 783945	11. 88	8. 811190	12. 65
6	. 784658	11. 88	. 811949	12. 65
7	. 785371	11 87	. 812708	12. 63
8	. 786083	11. 85	. 813466	12. 63
9	. 786794	11. 85	. 814224	12. 62
10	8. 787505	11. 83	8. 814981	12 60
11	. 788215	11. 82	. 815737	12. 60
12	. 788924	11. 82	. 816493	12. 60
13	. 789633	11. 82	. 817249	12. 58
14	. 790342	11. 78	818004	12. 57
15	8. 791049	11. 78	8. 818758	12. 57
16	. 791756	11. 78	. 819512	12. 55
17	. 792463	11. 77	. 820265	12. 55
18	. 793169	11. 75	. 821018	12. 53
19	. 793874	11. 75	. 821770	12. 52
20	8. 794579	11. 73	8. 822521	12. 52
21	. 795283	11. 73	. 823272	12. 52
22	. 795987	11. 72	. 824023	12. 50
23	. 796690	11. 70	. 824773	12. 48
24	. 797392	11. 70	. 825522	12. 48
25	8. 798094	11. 68	8. 826271	12 47
26	. 798795	11 68	. 827019	12. 47
27	. 799496	11 67	. 827767	12 45
28	. 800196	11. 67	. 828514	12. 45
29	. 800896	11. 63	. 829261	12. 43
30	8. 801594	11. 65	8. 830007	12. 42
31	. 802293	11 63	. 830752	12 42
32	. 802991	11. 62	. 831497	12. 42
33	. 803688	11 60	. 832242	12. 40
34	. 804384	11. 60	. 832986	12. 38
35	8. 805080	11. 60	8. 833729	12 38
36	. 805776	11. 58	. 834472	12. 38
37	. 806471	11 57	. 835215	12 37
38	. 807165	11. 57	. 835957	12. 35
39	. 807859	11. 55	. 836698	12. 35
40	8. 808552	11. 53	8. 39	12. 33
41	. 809244	11. 53	. 79	12 33
42	. 809936	11. 53	. 19	12. 32
43	. 810628	11 52	. 58	12. 30
44	811319	11. 50	. 96	12. 32
45	8. 812009	11. 50	8. 35	12 28
46	. 812699	11. 48	.[illegible]72	12. 28
47	. 813388	11. 48	. 842609	12. 28
48	. 814077	11. 47	. 843346	12. 27
49	. 814765	11. 45	. 844082	12. 25
50	8. 815452	11. 45	8. 844817	12. 25
51	. 816139	11. 43	. 845552	12 25
52	. 816825	11. 43	. 846287	12. 23
53	. 817511	11. 42	. 847021	12. 22
54	. 818196	11. 42	. 847754	12. 22
55	8. 818881	11. 40	8. 848487	12. 22
56	. 819565	11. 40	. 849220	12 20
57	. 820249	11. 38	. 849952	12 18
58	. 820932	11 37	. 850683	12 18
59	821614	11. 37	. 851414	12. 17
60	8. 822296		8. 852144	

21°

M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	8. 96	11. 35	8. 852144	12. 17
1	. 77	11. 35	. 852874	12. 17
2	. 58	11. 33	. 853604	12. 13
3	. 38	11. 33	. 854332	12. 15
4	. 18	11 32	855061	12 13
5	8. 97	11. 32	8. 855789	12. 12
6	. 76	11. 30	856516	12 12
7	. 54	11 28	. 857243	12. 10
8	. 31	11. 28	. 857969	12. 10
9	. 08	11. 28	. 858695	12. 08
10	8. 85	11 27	8. 20	12. 08
11	. 61	11. 25	. 45	12. 07
12	. 36	11. 25	. 69	12. 07
13	. 11	11. 23	. 93	12. 05
14	. 85	11. 23	. 16	12. 05
15	8. 59	11. 22	8. 39	12. 03
16	. 32	11. 20	. 61	12. 03
17	. 04	11. 20	. 83	12. 02
18	. 76	11. 20	. 04	12. 02
19	. 48	11. 18	. 25	12. 02
20	8. 19	11 17	8. 866646	11. 98
21	. 89	11. 17	. 867365	12. 00
22	. 59	11. 17	. 868085	11. 98
23	. 29	11. 15	. 868804	11. 97
24	. 98	11. 13	. 869522	11. 97
25	8. 66	11. 13	8. 870240	11. 95
26	. 34	11. 12	. 870957	11 95
27	. 01	11. 12	. 871674	11. 93
28	. 68	11. 10	. 872390	11. 93
29	. 34	11. 10	. 873106	11 93
30	8. 00	11. 08	8. 22	11. 92
31	. 65	11. 07	. 37	11 90
32	. 29	11. 07	. 51	11. 90
33	. 93	11. 07	. 65	11. 88
34	. 57	11. 05	. 78	11. 88
35	8. 20	11. 05	8. 91	11. 88
36	. 83	11. 03	. 04	11. 87
37	. 45	11. 02	. 16	11. 87
38	. 06	11. 02	. 28	11. 85
39	. 67	11. 00	. 39	11. 83
40	8. 849127	11 00	8. 880949	11. 83
41	. 849787	11 00	. 881659	11. 83
42	. 850447	10. 98	. 882369	11. 82
43	. 851106	10. 97	. 883078	11. 82
44	. 851764	10. 97	. 883787	11. 80
45	8. 852422	10. 95	8. 884495	11 80
46	. 853079	10. 95	. 885203	11 78
47	. 853736	10. 93	. 885910	11 78
48	. 854392	10. 93	. 886617	11 77
49	. 855048	10. 92	. 887323	11. 77
50	8. 855703	10. 92	8. 888029	11. 75
51	. 856358	10. 90	. 888734	11. 75
52	. 857012	10. 90	. 889439	11. 75
53	. 857666	10. 88	. 890144	11. 73
54	. 858319	10. 88	. 890848	11. 72
55	8. 858972	10. 87	8. 891551	11 72
56	. 859624	10. 87	. 892254	11 72
57	. 860276	10. 85	. 892957	11. 70
58	860927	10. 85	. 893659	11 70
59	861578	10. 83	. 894361	11. 68
60	8. 862228		8. 895062	

22°				
M.	Vers.	D. 1".	Exsec.	D. 1".
0	8.862228	10.83	8. 62	11.68
1	.862877	10.83	. 63	11.67
2	.863527	10.80	. 63	11.67
3	.864175	10.80	. 63	11.65
4	.864823	10.80	. 62	11.65
5	8.865471	10.78	8. 61	11.63
6	.866118	10.78	. 59	11.63
7	.866765	10.77	. 57	11.63
8	.867411	10.77	. 55	11.62
9	.868057	10.75	.901352	11.60
10	8. 02	10.73	8.902048	11.62
11	. 46	10.75	.902745	11.58
12	. 91	10.73	.903440	11.60
13	. 34	10.72	.904136	11.57
14	. 77	10.72	.904830	11.58
15	8. 20	10.70	8.905525	11.57
16	. 62	10.70	.906219	11.55
17	. 04	10.68	.906912	11.55
18	. 45	10.68	.907605	11.55
19	. 86	10.67	.908298	11.53
20	8.875126	10.67	8.908990	11.52
21	.875766	10.65	.909681	11.52
22	.876405	10.65	.910372	11.52
23	.877044	10.63	.911063	11.52
24	.877682	10.63	.911754	11.48
25	8.878320	10.62	8.912443	11.50
26	.878957	10.62	.913133	11.48
27	.879594	10.60	.913822	11.47
28	.880230	10.60	.914510	11.47
29	.880866	10.58	.915198	11.47
30	8.881501	10.58	8.915886	11.45
31	.882136	10.58	.916573	11.45
32	.882771	10.57	.917260	11.43
33	.883405	10.55	.917946	11.43
34	.884038	10.55	918632	11.43
35	8.884671	10.53	8.919318	11.42
36	.885303	10.53	920003	11.40
37	.885935	10.53	.920687	11.42
38	.886567	10.52	921372	11.38
39	.887198	10.52	.922055	11.40
40	8.887829	10.50	8.922739	11.37
41	.888459	10.48	.923421	11.38
42	.889088	10.48	.924104	11.37
43	.889717	10.48	.924786	11.35
44	.890346	10.47	.925467	11.37
45	8.890974	10.47	8.926149	11.33
46	.891602	10.45	.926829	11.35
47	.892229	10.45	.927510	11.32
48	.892856	10.43	.928189	11.33
49	.893482	10.43	.928869	11.32
50	8.894108	10.42	8.929548	11.30
51	.894733	10.42	.930226	11.32
52	.895358	10.42	.930905	11.28
53	.895983	10.40	931582	11.30
54	.896607	10.38	.932260	11.27
55	8.897230	10.38	8.932936	11.28
56	897653	10.38	.933613	11.27
57	.898476	10.37	.934289	11.27
58	.899098	10.35	.934965	11.25
59	.899719	10.37	.935640	11.25
60	8.900341		8.936315	

23°				
M	Ver			
0	8.900341	10.33	8.936315	11.23
1	.900961	10.35	.936989	11.23
2	.901582	10.32	937663	11.22
3	.902201	10.33	.938336	11.22
4	.902821	10.32	.939009	11.22
5	8.903440	10.30	8.939682	11.20
6	.904058	10.30	940354	11.20
7	.904676	10.28	.941026	11.20
8	.905293	10.28	.941698	11.18
9	.905910	10.28	.942369	11.17
10	8.906527	10.27	8.943039	11.18
11	.907143	10.27	.943710	11.15
12	.907759	10.25	.944379	11.17
13	.908374	10.25	.945049	11.15
14	.908989	10.23	.945718	11.13
15	8.909603	10.23	8.946386	11.13
16	.910217	10.22	.947054	11.13
17	.910830	10.22	.947722	11.12
18	.911443	10.22	.948389	11.12
19	.912056	10.20	.949056	11.12
20	8.912668	10.18	8.949723	11.10
21	.913279	10.20	.950389	11.10
22	.913891	10.17	.951055	11.08
23	.914501	10.17	.951720	11.08
24	.915111	10.17	.952385	11.07
25	8.915721	10.17	8.953049	11.07
26	.916331	10.15	.953713	11.07
27	.916940	10.13	.954377	11.05
28	.917548	10.13	.955040	11.05
29	.918156	10.13	.955703	11.05
30	8.918764	10.12	8.956366	11.03
31	.919371	10.10	.957028	11.03
32	.919977	10.12	.957690	11.02
33	.920584	10.10	.958351	11.02
34	.921190	10.08	.959012	11.00
35	8.921795	10.08	8.959672	11.00
36	922400	10.07	.960332	11.00
37	.923004	10.07	.960992	10.98
38	.923608	10.07	.961651	10.98
39	.924212	10.05	.962310	10.98
40	8.924815	10.05	8.962969	10.97
41	.925418	10.03	.963627	10.97
42	.926020	10.03	.964285	10.95
43	926622	10.03	.964942	10.95
44	.927224	10.02	.965599	10.95
45	8.927825	10.00	8.966256	10.93
46	.928425	10.00	.966912	10.93
47	.929025	10.00	967568	10.92
48	.929625	9.98	.968223	10.92
49	.930224	9.98	.968878	10.92
50	8.930823	9.97	8.969533	10.90
51	.931421	9.97	.970187	10.90
52	.932019	9.97	.970841	10.88
53	.932617	9.95	.971494	10.88
54	.933214	9.95	.972147	10.88
55	8.933811	9.93	8.972800	10.87
56	.934407	9.93	.973452	10.87
57	.935003	9.92	.974104	10.87
58	.935598	9.92	.974756	10.85
59	.936193	9.92	975407	10.85
60	8.936788		8.976058	

				″.	M.	Vers			″.
0	8.936788	9.90	8.976058	10.83	0	8.971703	9.50	9.014428	10.47
1	.937382	9.90	.976708	10.83	1	.972273	9.48	.015056	10.48
2	.937976	9.88	.977358	10.83	2	.972842	9.48	.015685	10.45
3	.938569	9.88	.978008	10.82	3	.973411	9.48	.016312	10.47
4	.939162	9.87	.978657	10.82	4	.973980	9.47	.016940	10.45
5	8.939754	9.87	8.979306	10.80	5	8.974548	9.47	9.017567	10.45
6	.940346	9.87	.979954	10.80	6	.975116	9.45	.018194	10.45
7	.940938	9.85	.980602	10.80	7	.975683	9.45	.018821	10.43
8	.941529	9.85	.981250	10.80	8	.976250	9.43	.019447	10.43
9	.942120	9.83	.981898	10.78	9	.976816	9.43	.020073	10.42
10	8.942710	9.83	8. 45	10.77	10	8.9 82	9.43	9.020698	10.42
11	.943300	9.82	. 91	10.77	11	.9 48	9.43	.021323	10.42
12	.943889	9.83	. 37	10.77	12	.9 14	9.40	.021948	10.40
13	.944479	9.80	. 83	10.77	13	.9 78	9.42	.022572	10.42
14	.945067	9.80	. 29	10.75	14	.9 43	9.40	.023197	10.38
15	8.945655	9.80	8. 74	10.75	15	8.9 07	9.40	9.023820	10.40
16	.946243	9.80	. 19	10.73	16	.9 71	9.40	.024444	10.38
17	.946831	9.78	. 63	10.73	17	.9 35	9.38	.025067	10.38
18	.947418	9.77	. 07	10.73	18	.9 98	9.37	.025690	10.37
19	.948004	9.77	. 51	10.72	19	.9 60	9.38	.026312	10.37
20	8.948590	9.77	8.988994	10.72	20	8.983023	9.37	9.026934	10.37
21	.949176	9.75	.989637	10.70	21	.983585	9.35	.027556	10.35
22	.949761	9.75	.990279	10.72	22	.984146	9.35	.028177	10.35
23	.950346	9.75	.990922	10.68	23	.984707	9.35	.028798	10.35
24	.950931	9.73	.991563	10.70	24	.985268	9.33	.029419	10.33
25	8.951515	9.73	8.992205	10.68	25	8.985828	9.33	9.030039	10.33
26	.952099	9.72	.992846	10.68	26	.986388	9.33	.030659	10.33
27	.952682	9.72	.993487	10.67	27	.986948	9.32	.031279	10.33
28	.953265	9.70	.994127	10.67	28	.987507	9.32	.031899	10.32
29	.953847	9.70	.994767	10.65	29	.988066	9.32	.032518	10.30
30	8.954429	9.70	8.995406	10.67	30	8.988625	9.30	9.033136	10.32
31	.955011	9.68	.996046	10.65	31	.989183	9.28	.033755	10.30
32	.955592	9.68	.996685	10.63	32	.989740	9.30	.034373	10.30
33	.956173	9.67	.997323	10.63	33	.990298	9.28	.034991	10.28
34	.956753	9.68	.997961	10.63	34	.990855	9.27	.035608	10.28
35	8.957334	9.65	8.998599	10.62	35	8.991411	9.28	9.036225	10.28
36	.957913	9.65	.999236	10.62	36	.991968	9.25	.036842	10.27
37	.958492	9.65	.999873	10.62	37	.992523	9.27	.037458	10.27
38	.959071	9.65	9.000510	10.62	38	.993079	9.25	.038074	10.27
39	.959650	9.62	.001147	10.60	39	.993634	9.25	.038690	10.25
40	8.960227	9.63	9.001783	10.58	40	8.994189	9.23	9.039305	10.25
41	.960805	9.62	.002418	10.58	41	.994743	9.23	.039920	10.25
42	.961382	9.62	.003053	10.58	42	.995297	9.23	.040535	10.25
43	.961959	9.60	.003688	10.58	43	.995851	9.22	.041150	10.23
44	962535	9.60	004323	10.57	44	.996404	9.22	.041764	10.23
45	8.963111	9.60	9.004957	10.57	45	8.996957	9.20	9.042378	10.22
46	.963687	9.58	.005591	10.55	46	.997509	9.22	.042991	10.22
47	964262	9.58	.006224	10.57	47	.998062	9.18	.043604	10.22
48	.964837	9.57	.006858	10.53	48	.998613	9.20	.044217	10.22
49	.965411	9.57	.007490	10.55	49	.999165	9.18	.044830	10.20
50	8.965985	9.57	9.008123	10.53	50	8.999716	9.17	9.045442	10.20
51	.966559	9.55	.008755	10.53	51	9.000266	9.18	.046054	10.18
52	.967132	9.55	.009387	10.52	52	.000817	9.17	.046665	10.18
53	.967705	9.53	.010018	10.52	53	.001367	9.15	.047276	10.18
54	.968277	9.53	.010649	10.52	54	.001916	9.17	.047887	10.18
55	8.968849	9.53	9.011280	10.50	55	9.002466	9.13	9.048498	10.17
56	.969421	9.52	.011910	10.50	56	.003014	9.15	.049108	10.17
57	.969992	9.52	.012540	10.50	57	.003563	9.13	.049718	10.17
58	970563	9.50	.013170	10.48	58	.004111	9.13	.050328	10.15
59	.971133	9.50	.013799	10.48	59	.004659	9.12	.050937	10.15
60	8.971703		9.014428		60	9.005206		9.051546	

					27°		D. 1".	Exsec.	D. 1".
0	9.005206	9.12	9.051546	10.15	0	9.037401	8.77	9.087520	9.83
1	.005753	9.12	.052155	10.13	1	.037927	8.75	.088110	9.83
2	.006300	9.10	.052763	10.13	2	.038452	8.77	.088700	9.83
3	.006846	9.10	.053371	10.13	3	.038978	8.75	.089290	9.83
4	.007392	9.10	.053979	10.12	4	.039503	8.73	.089880	9.82
5	9.007938	9.08	9.054586	10.12	5	9.040027	8.75	9.090469	9.82
6	.008483	9.08	.055193	10.12	6	.040552	8.73	.091058	9.82
7	.009028	9.07	.055800	10.10	7	.041076	8.72	.091647	9.80
8	.009572	9.07	.056406	10.10	8	.041599	8.73	.092235	9.80
9	.010116	9.07	.057012	10.10	9	.042123	8.72	.092823	9.80
10	9.010660	9.05	9.057618	10.10	10	9.042646	8.70	9.093411	9.78
11	.011203	9.05	.058224	10.08	11	.043166	8.72	.093998	9.80
12	.011746	9.05	.058829	10.08	12	.043691	8.70	.094586	9.78
13	.012289	9.03	.059434	10.07	13	.044213	8.70	.095173	9.77
14	.012831	9.03	.060038	10.08	14	.044735	8.68	.095759	9.78
15	9.013373	9.03	9.060643	10.07	15	9.045256	8.68	9.096346	9.77
16	.013915	9.02	.061247	10.05	16	.045777	8.68	.096932	9.77
17	.014456	9.02	.061850	10.07	17	.046298	8.67	.097518	9.75
18	.014997	9.02	.062454	10.05	18	.046818	8.67	.098103	9.77
19	.015538	9.00	.063057	10.03	19	.047338	8.67	.098689	9.75
20	9.016078	9.00	9.063659	10.05	20	9.047858	8.65	9.099274	9.73
21	.016618	8.98	.064262	10.03	21	.048377	8.65	.099858	9.75
22	.017157	9.00	.064864	10.03	22	.048896	8.65	.100443	9.73
23	.017697	8.97	.065466	10.02	23	.049415	8.63	.101027	9.73
24	.018235	8.98	.066067	10.02	24	.049933	8.63	.101611	9.72
25	9.018774	8.97	9.066668	10.02	25	9.050451	8.63	9.102194	9.73
26	.019312	8.97	.067269	10.02	26	.050969	8.63	.102778	9.72
27	.019850	8.95	.067870	10.00	27	.051487	8.62	.103361	9.70
28	.020387	8.95	.068470	10.00	28	.052004	8.60	.103943	9.72
29	.020924	8.95	.069070	10.00	29	.052520	8.62	.104526	9.70
30	9.021461	8.93	9.069670	9.98	30	9.053037	8.60	9.105108	9.70
31	.021997	8.93	.070269	9.98	31	.053553	8.60	.105690	9.68
32	.022533	8.93	.070868	9.98	32	.054069	8.58	.106271	9.70
33	.023069	8.92	.071467	9.97	33	.054584	8.58	.106853	9.68
34	.023604	8.92	.072065	9.97	34	.055099	8.58	.107434	9.68
35	9.024139	8.90	9.072663	9.97	35	9.055614	8.58	9.108015	9.67
36	.024673	8.90	.073261	9.97	36	.056129	8.57	.108595	9.67
37	.025208	8.90	.073859	9.95	37	.056643	8.57	.109175	9.67
38	.025742	8.88	.074456	9.95	38	.057157	8.55	.109755	9.67
39	.026275	8.88	.075053	9.93	39	.057670	8.55	.110335	9.65
40	9.026808	8.88	9.075649	9.95	40	9.058183	8.55	9.110914	9.67
41	.027341	8.88	.076246	9.93	41	.058696	8.55	.111494	9.63
42	.027874	8.87	.076842	9.92	42	.059209	8.53	.112072	9.65
43	.028406	8.87	.077437	9.93	43	.059721	8.53	.112651	9.63
44	.028938	8.85	.078033	9.92	44	.060233	8.53	.113229	9.63
45	9.029469	8.85	9.078628	9.92	45	9.060745	8.52	9.113807	9.63
46	.030000	8.85	.079223	9.90	46	.061256	8.52	.114385	9.63
47	.030531	8.85	.079817	9.92	47	.061767	8.50	.114963	9.62
48	.031062	8.83	.080413	9.90	48	.062277	8.52	.115540	9.62
49	.031592	8.83	.081006	9.88	49	.062788	8.50	.116117	9.60
50	9.032122	8.82	9.081599	9.90	50	9.063298	8.48	9.116693	9.62
51	.032651	8.82	.082193	9.88	51	.063807	8.50	.117270	9.60
52	.033180	8.82	.082786	9.87	52	.064317	8.48	.117846	9.60
53	.033709	8.80	.083378	9.88	53	.064826	8.48	.118422	9.58
54	.034237	8.80	.083971	9.87	54	.065335	8.47	.118997	9.60
55	9.034765	8.80	9.084563	9.87	55	9.065843	8.47	9.119573	9.58
56	.035293	8.78	.085155	9.87	56	.066351	8.47	.120148	9.58
57	.035820	8.78	.085747	9.85	57	.066859	8.45	.120723	9.57
58	.036347	8.78	.086338	9.85	58	.067366	8.47	.121297	9.57
59	.036874	8.78	.086929	9.85	59	.067874	8.45	.121871	9.57
60	9.037401		9.087520		60	9.068380		9.122445	

	28°					29°			
M.	Vers.	D. 1″.	Exsec.	D. 1″.	M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.068380	8.45	9.122445	9.57	0	9.098229	8.15	9.156410	9.30
1	.068887	8.43	.123019	9.57	1	.098718	8.13	.156968	9.32
2	.069393	8.43	.123593	9.55	2	.099206	8.12	.157527	9.28
3	.069899	8.43	.124166	9.55	3	.099693	8.13	.158084	9.30
4	.070405	8.42	.124739	9.53	4	.100181	8.12	.158642	9.30
5	9.070910	8.42	9.125311	9.55	5	9.100668	8.12	9.159200	9.28
6	.071415	8.40	.125884	9.53	6	.101155	8.12	.159757	9.28
7	.071919	8.42	.126456	9.53	7	.101642	8.10	.160314	9.27
8	.072424	8.40	.127028	9.52	8	.102128	8.10	.160870	9.28
9	.072928	8.40	.127599	9.53	9	.102614	8.10	.161427	9.27
10	9.073432	8.38	9.128171	9.52	10	9.103100	8.08	9.161983	9.27
11	.073935	8.38	.128742	9.52	11	.103585	8.08	.162539	9.27
12	.074438	8.38	.129313	9.50	12	.104070	8.08	.163095	9.25
13	.074941	8.37	.129883	9.50	13	.104555	8.08	.163650	9.25
14	.075443	8.38	.130453	9.50	14	.105040	8.07	.164205	9.25
15	9.075946	8.35	9.131023	9.50	15	9.105524	8.07	9.164760	9.25
16	.076447	8.37	.131593	9.50	16	.106008	8.05	.165315	9.25
17	.076949	8.35	.132163	9.48	17	.106491	8.07	.165870	9.23
18	.077450	8.35	.132732	9.48	18	.106975	8.05	.166424	9.23
19	.077951	8.35	.133301	9.48	19	.107458	8.05	.166978	9.23
20	5 52	8.33	9.133870	9.47	20	9.107941	8.03	9.167532	9.22
21	52	8.33	.134438	9.47	21	.108423	8.05	.168085	9.23
22	52	8.33	.135006	9.47	22	.108906	8.03	.168639	9.22
23	52	8.32	.135574	9.47	23	.109388	8.02	.169192	9.22
24	51	8.32	.136142	9.45	24	.109869	8.03	.169745	9.20
25	5 50	8.32	9.136709	9.47	25	9.110351	8.02	9.170297	9.22
26	49	8.32	.137277	9.45	26	.110832	8.02	.170850	9.20
27	48	8.30	.137844	9.43	27	.111313	8.00	.171402	9.20
28	46	8.30	.138410	9.45	28	.111793	8.00	.171954	9.18
29	44	8.28	.138977	9.43	29	.112273	8.00	.172505	9.20
30	9. 41	8.30	9.139543	9.43	30	9.112753	8.00	9.173057	9.18
31	. 39	8.28	.140109	9.42	31	.113233	8.00	.173608	9.18
32	. 36	8.27	.140674	9.43	32	.113713	7.98	.174159	9.18
33	. 32	8.28	.141240	9.42	33	.114192	7.98	.174710	9.17
34	. 29	8.27	.141805	9.42	34	.114671	7.97	.175260	9.17
35	9. 25	8.25	9.142370	9.40	35	9.115149	7.97	9.175810	9.17
36	. 20	8.27	.142934	9.42	36	.115627	7.97	.176360	9.17
37	. 16	8.25	.143499	9.40	37	.116105	7.97	.176910	9.17
38	. 11	8.25	.144063	9.40	38	.116583	7.97	.177460	9.15
39	. 06	8.23	.144627	9.38	39	.117061	7.95	.178009	9.15
40	9.088400	8.25	9.145190	9.40	40	9.117538	7.95	9.178558	9.15
41	.088895	8.23	.145754	9.38	41	.118015	7.93	.179107	9.15
42	.089389	8.22	.146317	9.38	42	.118491	7.95	.179656	9.13
43	.089882	8.23	.146880	9.37	43	.118968	7.93	.180204	9.13
44	.090376	8.22	.147442	9.38	44	.119444	7.92	.180752	9.13
45	9.090869	8.22	9.148005	9.37	45	9.119919	7.93	9.181300	9.13
46	.091362	8.20	.148567	9.37	46	.120395	7.92	.181848	9.12
47	.091854	8.20	.149129	9.35	47	.120870	7.92	.182395	9.13
48	.092346	8.20	.149690	9.35	48	.121345	7.92	.182943	9.12
49	.092838	8.20	.150251	9.37	49	.121820	7.90	.183490	9.10
50	9.093330	8.18	9.150813	9.33	50	9.122294	7.90	9.184036	9.12
51	.093821	8.18	.151373	9.35	51	.122768	7.90	.184583	9.10
52	.094312	8.18	.151934	9.33	52	.123242	7.88	.185129	9.10
53	.094803	8.17	.152494	9.35	53	.123715	7.90	.185675	9.10
54	.095293	8.17	.153055	9.32	54	.124189	7.88	.186221	9.10
55	9.095783	8.17	9.153614	9.33	55	9.124662	7.87	9.186767	9.08
56	.096273	8.17	.154174	9.32	56	.125134	7.88	.187312	9.10
57	.096763	8.15	.154733	9.33	57	.125607	7.87	.187858	9.08
58	.097252	8.15	.155293	9.30	58	.126079	7.87	.188403	9.07
59	.097741	8.13	.155851	9.32	59	.126551	7.85	.188947	9.08
60	9.098229		9.156410		60	9.127022		9.189492	

30°					31°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.	M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.127022	7.87	9.189492	9.07	0	9.154828	7.58	9.221762	8.85
1	.127494	7.85	.190036	9.07	1	.155283	7.58	.222293	8.87
2	.127965	7.85	.190580	9.07	2	.155738	7.58	.222825	8.83
3	.128436	7.83	.191124	9.07	3	.156193	7.58	.223355	8.85
4	.128906	7.83	.191668	9.05	4	.156648	7.57	.223886	8.85
5	9.129376	7.83	9.192211	9.05	5	9.157102	7.57	9.224417	8.83
6	.129846	7.83	.192754	9.05	6	.157556	7.57	.224947	8.83
7	.130316	7.82	.193297	9.05	7	.158010	7.57	.225477	8.83
8	.130785	7.83	.193840	9.03	8	.158464	7.55	.226007	8.83
9	.131255	7.82	.194382	9.05	9	.158917	7.55	.226537	8.82
10	9.131724	7.80	9.194925	9.03	10	9.159370	7.55	9.227066	8.82
11	.132192	7.80	.195467	9.03	11	.159823	7.55	.227595	8.83
12	.132660	7.82	.196009	9.02	12	.160276	7.53	.228125	8.80
13	.133129	7.78	.196550	9.03	13	.160728	7.53	.228653	8.82
14	.133596	7.80	.197092	9.02	14	.161180	7.53	.229182	8.82
15	9.134064	7.78	9.197633	9.02	15	9.161632	7.52	9.229711	8.80
16	.134531	7.78	.198174	9.02	16	.162083	7.53	.230239	8.80
17	.134998	7.78	.198715	9.00	17	.162535	7.52	.230767	8.80
18	.135465	7.77	.199255	9.00	18	.162986	7.52	.231295	8.78
19	.135931	7.77	.199795	9.00	19	.163437	7.50	.231822	8.80
20	9.136397	7.77	9.200335	9.00	20	9.163887	7.52	9.232350	8.78
21	.136863	7.77	.200875	9.00	21	.164338	7.50	.232877	8.78
22	.137329	7.75	.201415	8.98	22	.164788	7.48	.233404	8.78
23	.137794	7.77	.201954	9.00	23	.165237	7.50	.233931	8.78
24	.138260	7.73	.202494	8.98	24	.165687	7.48	.234458	8.77
25	9.138724	7.75	9.203033	8.97	25	9.166136	7.48	9.234984	8.77
26	.139189	7.73	.203571	8.98	26	.166585	7.48	.235510	8.77
27	.139653	7.73	.204110	8.97	27	.167034	7.48	.236036	8.77
28	.140117	7.73	.204648	8.97	28	.167483	7.47	.236562	8.77
29	.140581	7.73	.205186	8.97	29	.167931	7.47	.237088	8.75
30	9.141045	7.72	9.205724	8.97	30	9.168379	7.47	9.237613	8.77
31	.141508	7.72	.206262	8.95	31	.168827	7.47	.238139	8.75
32	.141971	7.72	.206799	8.97	32	.169275	7.45	.238664	8.75
33	.142434	7.70	.207337	8.95	33	.169722	7.45	.239189	8.73
34	.142896	7.70	.207874	8.93	34	.170169	7.45	.239713	8.75
35	9.143358	7.70	9.208410	8.95	35	9.170616	7.43	9.240238	8.73
36	.143820	7.70	.208947	8.93	36	.171062	7.45	.240762	8.73
37	.144282	7.68	.209483	8.95	37	.171509	7.43	.241286	8.73
38	.144743	7.68	.210020	8.93	38	.171955	7.42	.241810	8.72
39	.145204	7.68	.210556	8.92	39	.172400	7.43	.242333	8.73
40	9.145665	7.68	9.211091	8.93	40	9.172846	7.42	9.242857	8.72
41	.146126	7.67	.211627	8.92	41	.173291	7.42	.243380	8.72
42	.146586	7.67	.212162	8.92	42	.173736	7.42	.243903	8.72
43	.147046	7.67	.212697	8.92	43	.174181	7.42	.244426	8.72
44	.147506	7.67	.213232	8.92	44	.174626	7.40	.244949	8.70
45	9.147966	7.65	9.213767	8.90	45	9.175070	7.40	9.245471	8.72
46	.148425	7.65	.214301	8.92	46	.175514	7.40	.245994	8.70
47	.148884	7.65	.214836	8.90	47	.175958	7.40	.246516	8.70
48	.149343	7.63	.215370	8.90	48	.176402	7.38	.247038	8.68
49	.149801	7.63	.215904	8.88	49	.176845	7.38	.247559	8.70
50	9.150259	7.63	9.216437	8.90	50	9.177288	7.38	9.248081	8.68
51	.150717	7.63	.216971	8.88	51	.177731	7.38	.248602	8.68
52	.151175	7.63	.217504	8.88	52	.178174	7.37	.249123	8.68
53	.151633	7.62	.218037	8.88	53	.178616	7.37	.249644	8.68
54	.152090	7.62	.218570	8.87	54	.179058	7.37	.250165	8.68
55	9.152547	7.60	9.219102	8.88	55	9.179500	7.37	9.250686	8.67
56	.153003	7.62	.219635	8.87	56	.179942	7.35	.251206	8.67
57	.153460	7.60	.220167	8.87	57	.180383	7.37	.251726	8.67
58	.153916	7.60	.220699	8.87	58	.180825	7.33	.252246	8.67
59	.154372	7.60	.221231	8.85	59	.181265	7.35	.252766	8.67
60	9.154828		9.221762		60	9.181706		9.253286	

					35°				
				1".	M.	Vers.	D. 1".	Exsec.	D. 1".
0	9. 232901	6. 88	9. 314326	8. 32	0	9. 257314	6. 67	9. 343949	8. 15
1	. 233314	6. 88	. 314825	8. 30	1	. 257714	6. 68	. 344438	8. 15
2	. 233727	6. 87	. 315323	8. 30	2	. 258115	6. 67	. 344927	8. 15
3	. 234139	6. 88	. 315821	8. 30	3	. 258515	6. 67	. 345416	8. 13
4	. 234552	6. 87	. 316319	8. 30	4	. 258915	6. 65	. 345904	8. 15
5	9. 234964	6. 87	9. 316817	8. 28	5	9. 259314	6. 67	9. 346393	8. 13
6	. 235376	6. 87	. 317314	8. 28	6	. 259714	6. 65	. 346881	8. 13
7	. 235788	6. 85	. 317811	8. 30	7	. 260113	6. 65	. 347369	8. 13
8	. 236199	6. 87	. 318309	8. 28	8	. 260512	6. 65	. 347857	8. 13
9	. 236611	6. 85	. 318806	8. 28	9	. 260911	6. 65	. 348345	8. 13
10	9. 237022	6. 85	9. 319303	8. 27	10	9. 261310	6. 65	9. 348833	8. 13
11	. 237433	6. 85	. 319799	8. 28	11	. 261709	6. 63	. 349321	8. 12
12	. 237844	6. 83	. 320296	8. 27	12	. 262107	6. 63	. 349808	8. 12
13	. 238254	6. 85	. 320792	8. 28	13	. 262505	6. 63	. 350295	8. 12
14	. 238665	6. 83	. 321289	8. 27	14	. 262903	6. 63	. 350782	8. 12
15	9. 239075	6. 83	9. 321785	8. 27	15	9. 263301	6. 62	9. 351269	8. 12
16	. 239485	6. 82	. 322281	8. 25	16	. 263698	6. 63	. 351756	8. 12
17	. 239894	6. 83	. 322776	8. 27	17	. 264096	6. 62	. 352243	8. 12
18	. 240304	6. 82	. 323272	8. 27	18	. 264493	6. 62	. 352730	8. 10
19	. 240713	6. 82	. 323768	8. 25	19	. 264890	6. 62	. 353216	8. 10
20	9. 241122	6. 82	9. 324263	8. 25	20	9. 265287	6. 60	9. 353702	8. 10
21	. 241531	6. 82	. 324758	8. 25	21	. 265683	6. 62	. 354188	8. 10
22	. 241940	6. 80	. 325253	8. 25	22	. 266080	6. 60	. 354674	8. 10
23	. 242348	6 80	. 325748	8. 25	23	. 266476	6. 60	. 355160	8. 10
24	. 242756	6. 80	. 326243	8. 23	24	. 266872	6. 58	. 355646	8. 08
25	9. 243164	6. 80	9. 326737	8. 25	25	9. 267267	6. 60	9. 356131	8. 10
26	. 243572	6. 80	. 327232	8. 23	26	. 267663	6. 58	. 356617	8. 08
27	. 243980	6. 78	. 327726	8. 23	27	. 268058	6. 58	. 357102	8. 08
28	. 244387	6. 78	. 328220	8. 23	28	268453	6. 58	. 357587	8. 08
29	. 244794	6. 78	. 328714	8. 22	29	. 268848	6. 58	. 358072	8. 08
30	9. 245201	6. 78	9. 329207	8. 23	30	9. 269243	6. 58	9. 358557	8. 08
31	. 245608	6. 77	. 329701	8. 23	31	. 269638	6. 57	. 359042	8. 07
32	. 246014	-. 78	. 330195	8. 22	32	. 270032	6. 57	. 359526	8. 08
33	. 246421	6. 77	. 330688	8. 22	33	. 270426	6. 57	. 360011	8. 07
34	. 246827	6. 77	331181	8. 22	34	. 270820	6. 57	360495	8. 07
35	9. 247233	6. 77	9. 331674	8. 22	35	9. 271214	6. 57	9. 360979	8. 07
36	. 247639	6. 75	. 332167	8. 20	36	. 271608	6. 55	. 361463	8. 07
37	. 248044	6. 75	. 332659	8. 22	37	. 272001	6. 55	. 361947	8. 07
38	. 248449	6. 75	. 333152	8. 20	38	. 272394	6. 55	. 362431	8. 05
39	. 248854	6. 75	. 333644	8. 22	39	. 272787	6. 55	. 362914	8. 07
40	9. 249259	6. 75	9. 334137	8. 20	40	9. 273180	6 53	9. 363398	8. 05
41	. 249664	6. 73	. 334629	8. 20	41	. 273572	6. 55	. 363881	8. 05
42	. 250068	6. 75	. ----21	8. 18	42	. 273965	6. 53	. 364364	8. 05
43	. 250473	6. 73	. 12	8. 20	43	. 274357	6. 53	. 364847	8. 05
44	. 250877	6. 73	. 04	8. 18	44	. 274749	6. 53	. 365330	8. 05
45	9. 251281	6. 73	9. 95	8. 20	45	9. 275141	6. 52	9. 365813	8. 03
46	. 251684	6. 73	. 87	8. 18	46	. 275532	6. 53	. 366295	8. 05
47	. 252088	6. 72	. 78	8. 18	47	. 275924	6. 52	. 366778	8. 03
48	. 252491	6. 72	. 69	8. 18	48	. 276315	6. 52	. 367260	8. 03
49	. 252894	6. 72	. 60	8. 17	49	. 276706	6. 52	. 367742	8. 03
50	9. 253297	6. 70	9. 339050	8. 18	50	9. 277097	6. 52	9. 368224	8. 03
51	. 253699	6. 72	. 339541	8. 17	51	. 277488	6. 50	. 368706	8. 03
52	. 254102	6. 70	. 340031	8. 18	52	. 277878	6. 50	. 369188	8. 03
53	. 254504	6. 70	. 340522	8. 17	53	. 278268	6. 50	. 369670	8. 02
54	. 254906	6. 70	. 341012	8. 17	54	. 278658	6. 50	. 370151	8. 02
55	9. 255308	6. 68	9. 341502	8. 15	55	9. 279048	6. 50	9. 370632	8. 03
56	. 255709	6. 70	341991	8. 17	56	279438	6. 48	. 371114	8. 02
57	. 256111	6. 68	. 342481	8. 17	57	. 279827	6. 50	. 371595	8. 02
58	. 256512	6. 68	. 342971	8. 15	58	. 280217	6. 48	. 372076	8. 00
59	. 256913	6. 68	. 343460	8. 15	59	. 280606	6. 48	. 372556	8. 02
60	9. 257314		9. 343949		60	9. 280995		9. 373037	

0	9.326314	6.12	9.429782	7.75
1	.326681	6.10	.430247	7.77
2	.327047	6.12	430713	7.75
3	.327414	6.10	.431178	7.75
4	.327780	6.10	431643	7.75
5	9.328146	6.10	9.432108	7.75
6	.328512	6.10	.432573	7.75
7	.328878	6.08	.433038	7.75
8	.329243	6.10	.433503	7.73
9	.329609	6.08	.433967	7.75
10	9.329974	6.08	9.434432	7.73
11	.330339	6.08	.434896	7.75
12	.330704	6.08	.435361	7.73
13	.331069	6.07	.435825	7.73
14	.331433	6.08	.436289	7.73
15	9.331798	6.07	9.436753	7.73
16	.332162	6.07	.437217	7.72
17	.332526	6.07	.437680	7.73
18	.332890	6.07	.438144	7.73
19	.333254	6.05	.438608	7.72
20	9.333617	6.07	9.439071	7.72
21	333981	6.05	.439534	7.72
22	.334344	6.05	.439997	7.72
23	.334707	6.05	440460	7.72
24	.335070	6.03	.440923	7.72
25	9.335432	6.05	9.441386	7.72
26	.335795	6.03	.441849	7.72
27	.336157	6.03	.442312	7.70
28	.336519	6.03	.442774	7.72
29	.336881	6.03	.443237	7.70
30	9.337243	6.03	9.443699	7.70
31	.337605	6.02	.444161	7.70
32	.337966	6.03	.444623	7.70
33	.338328	6.02	.445085	7.70
34	.338689	6.02	.445547	7.70
35	9.339050	6.02	9.446009	7.68
36	.339411	6.00	.446470	7.70
37	.339771	6.02	.446932	7.68
38	.340132	6.00	.447393	7.70
39	.340492	6.00	.447855	7.68
40	9.340852	6.00	9.448316	7.68
41	.341212	6.00	.448777	7.68
42	.341572	6.00	.449238	7.68
43	.341932	5.98	.449699	7.68
44	.342291	6.00	.450160	7.67
45	9.342651	5.98	9.450620	7.68
46	.343010	5.98	451081	7.67
47	.343369	5.98	.451541	7.68
48	.343728	5.97	.452002	7.67
49	.344086	5.98	.452462	7.67
50	9.344445	5.97	9.452922	7.67
51	.344803	5.97	.453382	7.67
52	.345161	5.97	.453842	7.67
53	.345519	5.97	.454302	7.67
54	.345877	5.97	.454762	7.65
55	9.346235	5.95	9.455221	7.67
56	.346592	5.97	.455681	7.65
57	.346950	5.95	.456140	7.67
58	.347307	5.95	.456600	7.65
59	.347664	5.95	.457059	7.65
60	9.348021		9.457518	

39°

M.	Vers.	D. 1".	Exsec.	D. 1".
0	9.348021	5.93	9.457518	7.65
1	.348377	5.95	.457977	7.65
2	.348734	5.93	.458436	7.65
3	.349090	5.93	.458895	7.63
4	.349446	5.93	.459353	7.65
5	9.349802	5.93	9.459812	7.63
6	.350158	5.93	.460270	7.65
7	.350514	5.92	.460729	7.63
8	.350869	5.93	.461187	7.63
9	.351225	5.92	.461645	7.63
10	9.351580	5.92	9. 03	7.65
11	.351935	5.92	. 61	7.63
12	.352290	5.90	. 19	7.63
13	.352644	5.92	. 77	7.62
14	.352999	5.90	. 34	7.63
15	9.353353	5.90	9. 92	7.62
16	.353707	5.92	. 49	7.63
17	.354062	5.88	. 07	7.62
18	.354415	5.90	. 64	7.62
19	.354769	5.90	. 21	7.62
20	9.355123	5.88	9.466678	7.62
21	.355476	5.88	.467135	7.62
22	.355829	5.88	.467592	7.62
23	.356182	5.88	.468049	7.62
24	.356535	5.88	468506	7.60
25	9.356888	5.88	9.468962	7.60
26	.357241	5.87	.469418	7.62
27	.357593	5.87	.469875	7.60
28	.357945	5.87	.470331	7.60
29	358297	5.87	.470787	7.60
30	9.358649	5.87	9.471243	7.60
31	.359001	5.87	.471699	7.60
32	.359353	5.85	.472155	7.60
33	.359704	5.87	.472611	7.60
34	.360056	5.85	.473067	7.58
35	9.360407	5.85	9.473522	7.60
36	.360758	5.83	.473978	7.58
37	.361108	5.85	.474433	7.58
38	.361459	5.85	.474888	7.58
39	.361810	5.83	.475343	7.58
40	9.362160	5.83	9. 198	7.58
41	.362510	5.83	. 153	7.58
42	.362860	5.83	. 108	7.58
43	.363210	5.83	. 163	7.58
44	.363560	5.82	518	7.57
45	9.363909	5.83	9. 772	7.58
46	.364259	5.82	527	7.57
47	.364608	5.82	. 981	7.57
48	.364957	5.82	. 135	7.58
49	.365306	5.82	. 190	7.57
50	9.365655	5.80	9.480344	7.57
51	.366003	5.82	.480798	7.57
52	.366352	5.80	.481252	7.55
53	.366700	5.80	.481705	7.57
54	.367048	5.80	.482159	7.57
55	9.367396	5.80	9.482613	7.55
56	.367744	5.78	.483066	7.57
57	.368091	5.80	.483520	7.55
58	.368439	5.78	.483973	7.55
59	368786	5.78	484426	7.55
60	9.369133		9.484879	

40°					41°				
M.	Vers.	D. 1".	Exsec.	D. 1".	M.	Vers.	D. 1".	Exsec.	D. 1"
0	9.369133	5.78	9. 79	7.53	0	9.389681	5.62	9.511901	7.45
1	.369480	5.78	. 32	7.55	1	.390018	5.63	.512348	7.47
2	.369827	5.78	. 85	7.55	2	.390356	5.63	.512796	7.45
3	.370174	5.77	. 38	7.55	3	.390694	5.62	.513243	7.47
4	.370520	5.78	. 91	7.55	4	.391031	5.60	.513691	7.45
5	9.370867	5.77	9. 44	7.53	5	9.391368	5.62	9.514138	7.45
6	.371213	5.77	. 96	7.55	6	.391705	5.62	.514585	7.47
7	.371559	5.77	. 49	7.58	7	.392042	5.62	.515033	7.45
8	.371905	5.77	. 01	7.53	8	.392379	5.62	.515480	7.45
9	.372251	5.75	. 53	7.55	9	.392716	5.60	.515927	7.45
10	9.372596	5.77	9.489406	7.53	10	9.393052	5.60	9.516374	7.43
11	.372942	5.75	.489858	7.53	11	.393388	5.60	.516820	7.45
12	.373287	5.75	490310	7.53	12	.393724	5.62	.517267	7.45
13	.373632	5.75	.490762	7.53	13	.394061	5.58	.517714	7.43
14	.373977	5.75	.491214	7.52	14	.394396	5.60	.518160	7.45
15	9.374322	5.75	9.491665	7.53	15	9.394732	5.60	9.518607	7.43
16	374667	5.73	.492117	7.53	16	.395068	5.58	.519053	7.45
17	.375011	5.75	.492569	7.52	17	.395403	5.58	.519500	7.43
18	.375356	5.73	.493020	7.52	18	.395738	5.60	.519946	7.43
19	.375700	5.73	.493471	7.53	19	.396074	5.58	.520392	7.43
20	9.376044	5.73	9.493923	7.52	20	9.396409	5.57	9.520838	7.43
21	.376388	5.73	.494374	7.52	21	.396743	5.58	.521284	7.43
22	.376732	5.72	.494825	7.52	22	.397078	5.58	.521730	7.43
23	.377075	5.73	.495276	7.52	23	.397413	5.57	.522176	7.42
24	.377419	5.72	495727	7.52	24	.397747	5.57	.522621	7.43
25	9.377762	5.72	9.496178	7.50	25	9.398081	5.57	9.523067	7.43
26	.378105	5.72	.496628	7.52	26	.398415	5.57	.523513	7.42
27	.378448	5.72	.497079	7.52	27	.398749	5.57	.523958	7.43
28	.378791	5.70	.497530	7.50	28	.399083	5.57	.524404	7.42
29	.379133	5.72	.497980	7.50	29	.399417	5.55	.524849	7.42
30	9. 76	5.70	9.498430	7.52	30	9.399750	5.57	9.525294	7.42
31	. 18	5.72	.498881	7.50	31	.400084	5.55	.525739	7.42
32	. 61	5.70	.499331	7.50	32	.400417	5.55	.526184	7.42
33	. 03	5.70	.499781	7.50	33	.400750	5.55	.526629	7.42
34	45	5.68	.500231	7.50	34	.401083	5.55	.527074	7.42
35	9. 86	5.70	9.500681	7.50	35	9.401416	5.53	9.527519	7.42
36	. 28	5.68	.501131	7.50	36	.401748	5.55	.527964	7.42
37	. 69	5.70	.501581	7.48	37	.402081	5.53	.528409	7.40
38	. 11	5.68	.502030	7.50	38	.402413	5.53	.528853	7.42
39	. 52	5.68	.502480	7.48	39	.402745	5.53	.529298	7.40
40	9. 93	5.68	9.502929	7.50	40	9.403077	5.53	9.529742	7.42
41	. 34	5.67	.503379	7.48	41	.403409	5.53	.530187	7.40
42	. 74	5.68	.503828	7.48	42	.403741	5.53	.530631	7.40
43	. 15	5.67	.504277	7.48	43	.404073	5.52	.531075	7.40
44	. 55	5.67	.504726	7.48	44	.404404	5.53	.531519	7.40
45	9. 95	5.67	9.505175	7.48	45	9.404736	5.52	9.531963	7.40
46	. 35	5.67	.505624	7.48	46	.405067	5.52	.532407	7.40
47	. 75	5.67	.506073	7.48	47	.405398	5.52	.532851	7.40
48	. 15	5.67	.506522	7.48	48	.405729	5.50	.533295	7.40
49	. 55	5.65	.506971	7.47	49	.406059	5.52	.533739	7.38
50	9.386294	5.67	9.507419	7.48	50	9.406390	5.52	9.534182	7.40
51	.386634	5.65	.507868	7.47	51	406721	5.50	.534626	7.40
52	.386973	5.65	.508316	7.48	52	.407051	5.50	.535070	7.38
53	.387312	5.65	.508765	7.47	53	.407381	5.50	.535513	7.38
54	.387651	5.63	.509213	7.47	54	.407711	5.50	.535956	7.40
55	9.387989	5.65	9.509661	7.47	55	9.408041	5.50	9.536400	7.38
56	.388328	5.63	.510109	7.47	56	408371	5.48	.536843	7.38
57	.388666	5.65	.510557	7.47	57	.408700	5.50	.537286	7.38
58	.389005	5.63	.511005	7.47	58	.409030	5.48	.537729	7.38
59	.389343	5.63	.511453	7.47	59	.409359	5.48	.538172	7.38
60	9.389681		9.511901		60	9.409688		9.538615	

42°					43°				
M.				″.	M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.409688	5.48	9.538615	7.38	0	9.429181	5.35	9. 53	7.32
1	.410017	5.48	.539058	7.37	1	429502	5.33	. 92	7.30
2	.410346	5.48	.539500	7.38	2	.429822	5.33	. 30	7.32
3	.410675	5.48	.539943	7.38	3	430142	5.35	. 69	7.30
4	.411004	5.47	.540386	7.37	4	.430463	5.33	. 97	7.30
5	9.411332	5.47	9.540828	7.38	5	9.430783	5.33	9. 45	7.30
6	.411660	5.48	.541271	7.37	6	.431103	5.32	. 83	7.30
7	.411989	5.47	.541713	7.37	7	.431422	5.33	. 21	7.30
8	.412317	5.45	.542155	7.37	8	.431742	5.33	. 59	7.30
9	.412644	5.47	.542597	7.38	9	.432062	5.32	. 97	7.30
10	9.412972	5.47	9.543040	7.37	10	9.432381	5.32	9.569435	7.30
11	413300	5.45	.543482	7.37	11	.432700	5.33	.569873	7.30
12	.413627	5.47	.543924	7.37	12	.433020	5.32	.570311	7.28
13	.413955	5.45	.544366	7.35	13	.433339	5.30	.570748	7.30
14	.414282	5.45	.544807	7.37	14	.433657	5.32	.571186	7.30
15	9.414609	5.45	9.545249	7.37	15	9.433976	5.32	9.571624	7.28
16	.414936	5.43	.545691	7.35	16	.434295	5.30	.572061	7.28
17	.415262	5.45	.546132	7.37	17	.434613	5.32	.572498	7.30
18	.415589	5.45	.546574	7.35	18	.434932	5.30	.572936	7.28
19	.415916	5.43	.547015	7.37	19	.435250	5.30	.573373	7.28
20	9.416242	5.43	9.547457	7.35	20	9.435568	5.30	9.573810	7.28
21	.416568	5.43	.547898	7.35	21	.435886	5.30	.574247	7.30
22	.416894	5.43	.548339	7.37	22	.436204	5.28	.574685	7.28
23	.417220	5.43	.548781	7.35	23	.436521	5.30	.575122	7.27
24	.417546	5.42	.549222	7.35	24	.436839	5.28	.575558	7.28
25	9.417871	5.43	9.549663	7.35	25	9.437156	5.28	9.575995	7.28
26	.418197	5.42	.550104	7.33	26	.437473	5.30	.576432	7.28
27	.418522	5.43	.550544	7.35	27	.437791	5.27	.576869	7.28
28	.418848	5.42	.550985	7.35	28	.438107	5.28	.577306	7.27
29	.419173	5.42	.551426	7.35	29	.438424	5.28	.577742	7.28
30	9.419498	5.40	9.551867	7.33	30	9.438741	5.28	9.578179	7.27
31	.419822	5.42	.552307	7.35	31	.439058	5.27	.578615	7.28
32	.420147	5.40	.552748	7.33	32	.439374	5.27	.579052	7.27
33	.420471	5.42	.553188	7.35	33	.439690	5.28	.579488	7.27
34	.420796	5.40	.553629	7.33	34	.440007	5.27	.579924	7.28
35	9.421120	5.40	9.554069	7.33	35	9.440123	5.27	9.580361	7.27
36	.471444	5.40	.554509	7.33	36	.440639	5.25	.580797	7.27
37	.421768	5.40	.554949	7.33	37	.440954	5.27	.581233	7.27
38	.422092	5.40	.555389	7.33	38	.441270	5.27	.581669	7.27
39	.422416	5.38	.555829	7.33	39	.441586	5.25	.582105	7.27
40	9.422739	5.40	9.556269	7.33	40	9.441901	5.25	9. 41	7.27
41	.423063	5.38	.556709	7.33	41	.442216	5.25	77	7.27
42	.423386	5.38	.557149	7.33	42	.442531	5.25	. 13	7.25
43	.423709	5.38	.557589	7.32	43	.442846	5.25	. 48	7.27
44	.424032	5.38	.558028	7.33	44	.443161	5.25	. 84	7.27
45	9.424355	5.37	9.558468	7.32	45	9.443476	5.23	9. 20	7.25
46	.424677	5.38	.558907	7.33	46	.443790	5.25	. 55	7.27
47	.425000	5.37	.559347	7.32	47	.444105	5.23	. 91	7.25
48	.425322	5.38	.559786	7.33	48	.444419	5.23	. 26	7.27
49	.425645	5.37	.560226	7.32	49	.444733	5.23	. 62	7.25
50	9.425967	5.37	9.560665	7.32	50	9.445047	5.23	9.586897	7.25
51	.426289	5.37	.561104	7.32	51	.445361	5.23	.587332	7.25
52	.426611	5.37	.561543	7.32	52	.445675	5.23	.587767	7.27
53	.426933	5.35	.561982	7.32	53	.445989	5.22	.588203	7.25
54	.427254	5.37	.562421	7.32	54	446302	5.23	.588638	7.25
55	9.427576	5.35	9.562860	7.32	55	9.446616	5.22	9.589073	7.25
56	.427897	5.35	.563299	7.32	56	.446929	5.22	.589508	7.23
57	.428218	5.35	.563738	7.30	57	.447242	5.22	.589942	7.23
58	.428539	5.35	.564176	7.32	58	.447555	5.22	.590377	7.25
59	.428860	5.35	.564615	7.30	59	.447868	5.22	.590812	7.25
60	9.429181		9.565053		60	9.448181		9.591247	

	°				45°				
				".	M.	Vers.	D. 1".	Exsec.	D. 1".
0	9.448181	5.20	9.591247	7.23	0	9.466709	5.08	9.[illegible]224	7.20
1	.448493	5.22	.591681	7.25	1	.467014	5.08	.[illegible]556	7.18
2	.448806	5.20	.592116	7.25	2	.467319	5.08	.[illegible]87	7.19
3	.449118	5.22	.592551	7.23	3	.467624	5.07	.[illegible]518	7.18
4	.449431	5.20	.592985	7.23	4	.467928	5.08	.[illegible]49	7.18
5	9.449743	5.20	9.593419	7.25	5	9.468233	5.07	9.[illegible]80	7.18
6	.450055	5.18	.593854	7.23	6	.468537	5.07	.[illegible]11	7.18
7	.450366	5.20	.594288	7.23	7	.468841	5.07	.[illegible]42	7.18
8	.450678	5.20	.594722	7.23	8	.469145	5.07	.[illegible]573	7.18
9	.450990	5.18	.595156	7.25	9	.469449	5.07	.[illegible]104	7.18
10	9.451301	5.18	9.[illegible]91	7.23	10	9.469753	5.07	9.621535	7.18
11	.451613	5.20	.[illegible]25	7.23	11	.470057	5.05	.621966	7.17
12	.451924	5.18	.[illegible]59	7.23	12	.470360	5.07	.622396	7.18
13	.452235	5.18	.[illegible]93	7.22	13	.470664	5.05	.622827	7.18
14	.452546	5.17	.[illegible]26	7.23	14	.470967	5.05	.623258	7.17
15	9.452856	5.18	9.[illegible]60	7.23	15	9.471270	5.05	9.623688	7.18
16	.453167	5.18	.[illegible]94	7.23	16	.471573	5.05	.624119	7.17
17	.453478	5.17	.[illegible]28	7.22	17	.471876	5.05	.624549	7.18
18	.453788	5.17	.[illegible]61	7.23	18	.472179	5.05	.624980	7.17
19	.454098	5.17	.599495	7.22	19	.472482	5.03	.625410	7.18
20	9.454408	5.17	9.599928	7.23	20	9.472784	5.05	9.625841	7.17
21	.454718	5.17	.600362	7.22	21	.473087	5.03	.626271	7.17
22	.455028	5.17	.600795	7.23	22	.473389	5.03	.626701	7.17
23	.455338	5.17	.601229	7.22	23	.473691	5.03	.627131	7.17
24	.455648	5.15	.601662	7.22	24	.473993	5.03	.627561	7.17
25	9.455957	5.17	9.602095	7.22	25	9.474295	5.03	9.627991	7.17
26	.456267	5.15	.602528	7.23	26	.474597	5.03	.628421	7.17
27	.456576	5.15	.602962	7.22	27	.474899	5.02	.628851	7.17
28	.456885	5.15	.603395	7.22	28	.475200	5.03	.629281	7.17
29	.457194	5.15	.603828	7.22	29	.475502	5.02	.629711	7.17
30	9.457503	5.13	9.604261	7.22	30	9.475803	5.02	9.630141	7.17
31	.457811	5.15	.604694	7.20	31	.476104	5.02	.630571	7.17
32	.458120	5.15	.605126	7.22	32	.476405	5.02	.631001	7.15
33	.458429	5.13	.605559	7.22	33	.476706	5.02	.631430	7.17
34	.458737	5.13	.605992	7.22	34	.477007	5.02	.631860	7.17
35	9.459045	5.13	9.606425	7.20	35	9.477308	5.00	9.632290	7.15
36	.459353	5.13	.606857	7.22	36	.477608	5.02	.632719	7.17
37	.459661	5.13	.607290	7.20	37	.477909	5.00	.633149	7.15
38	.459969	5.13	.607722	7.22	38	.478209	5.00	.633578	7.17
39	.460277	5.12	.608155	7.20	39	.478509	5.00	.634008	7.15
40	9.460584	5.13	9.608587	7.22	40	9.478809	5.00	9.[illegible]37	7.15
41	.460892	5.12	.609020	7.20	41	479109	5.00	.[illegible]66	7.17
42	.461199	5.12	.609452	7.20	42	.479409	5.00	.[illegible]96	7.15
43	.461506	5.12	.609884	7.20	43	.479709	5.00	.[illegible]25	7.15
44	.461813	5.12	.610316	7.22	44	.480009	4.98	.[illegible]54	7.15
45	9.462120	5.12	9.610749	7.20	45	9.480308	5.00	9.[illegible]83	7.15
46	.462427	5.12	.611181	7.20	46	.480608	4.98	.[illegible]12	7.15
47	.462734	5.10	.611613	7.20	47	.480907	4.98	.[illegible]41	7.15
48	.463040	5.12	.612045	7.20	48	.481206	4.98	.[illegible]70	7.15
49	.463347	5.10	.612477	7.18	49	.481505	4.98	.[illegible]99	7.15
50	9.463653	5.10	9.612908	7.20	50	9.481804	4.98	9.638728	7.15
51	.463959	5.10	.613340	7.20	51	.482103	4.97	.639157	7.15
52	.464265	5.10	.613772	7.20	52	.482401	4.98	.639586	7.15
53	.464571	5.10	.614204	7.18	53	.482700	4.97	.640015	7.13
54	.464877	5.10	.614635	7.20	54	.482998	4.97	.640443	7.15
55	9.465183	5.08	9.615067	7.20	55	9.483296	4.98	9.640872	7.15
56	.465488	5.10	615499	7.18	56	.483595	4.97	.641301	7.13
57	.465794	5.08	.615930	7.20	57	.483893	4.97	.641729	7.15
58	.466099	5.08	.616362	7.18	58	.484191	4.95	.642158	7.13
59	.466404	5.08	.616793	7.18	59	.484488	4.97	.642586	7.15
60	9.466709		9.617224		60	9.484766		9.643015	

46°

					M.	V			
0	9. …86	4.97	9.643015	7.13	0	9.502429	4.85	9. …46	7.10
1	. …84	4.95	.643443	7.15	1	.502720	4.83	. …72	7.10
2	. …81	4.95	.643872	7.13	2	.503010	4.83	. …98	7.10
3	. …78	4.97	.644300	7.13	3	.503300	4.85	. …24	7.10
4	. …76	4.95	.644728	7.13	4	.503591	4.83	. …50	7.10
5	9. …73	4.95	9.645156	7.15	5	9.503881	4.83	9. …76	7.08
6	. …70	4.93	.645585	7.13	6	.504171	4.82	. …01	7.10
7	. …66	4.95	.646013	7.13	7	.504460	4.83	. …27	7.10
8	. …63	4.95	.646441	7.13	8	.504750	4.83	. …53	7.10
9	. …60	4.93	.646869	7.13	9	.505040	4.82	. …79	7.08
10	9. …56	4.95	9.647297	7.13	10	9.505329	4.82	9. …04	7.10
11	. …53	4.93	.647725	7.13	11	.505618	4.83	. …30	7.10
12	. …49	4.93	.648153	7.13	12	.505908	4.83	. …56	7.08
13	. …45	4.93	.648581	7.13	13	.506197	4.82	. …81	7.10
14	. …41	4.93	.649009	7.12	14	.506486	4.82	. …07	7.08
15	9. …37	4.93	9.649436	7.13	15	9.506775	4.80	9. …32	7.10
16	. …33	4.92	.649864	7.13	16	.507063	4.82	. …58	7.08
17	. …28	4.93	.650292	7.13	17	.507352	4.80	. …83	7.10
18	. …24	4.92	.650720	7.12	18	.507640	4.82	. …09	7.08
19	.490419	4.92	.651147	7.13	19	.507929	4.80	. …34	7.08
20	9.490714	4.93	9.651575	7.12	20	9.508217	4.80	9. …59	7.08
21	.491010	4.92	.652002	7.13	21	.508505	4.80	. …84	7.10
22	.491305	4.92	.652430	7.12	22	.508793	4.80	. …10	7.08
23	.491600	4.90	.652857	7.13	23	.509081	4.80	. …35	7.08
24	.491894	4.92	.653285	7.12	24	.509369	4.80	. …60	7.08
25	9.492189	4.92	9.653712	7.13	25	9.509657	4.80	9. …85	7.08
26	.492484	4.90	.654140	7.12	26	.509945	4.78	. …10	7.10
27	.492778	4.90	.654567	7.12	27	.510232	4.80	. …36	7.08
28	.493072	4.92	.654994	7.12	28	.510520	4.78	. …61	7.08
29	.493367	4.90	.655421	7.13	29	.510807	4.78	. …86	7.08
30	9.493661	4.90	9.655849	7.12	30	9.511094	4.78	9. …11	7.08
31	.493955	4.90	.656276	7.12	31	.511381	4.78	. …36	7.07
32	.494249	4.88	.656703	7.12	32	.511668	4.78	. …60	7.08
33	.494542	4.90	.657130	7.12	33	.511955	4.77	. …85	7.08
34	.494836	4.90	.657557	7.12	34	.512241	4.78	. …10	7.08
35	9.495130	4.88	9.657984	7.12	35	9.512528	4.78	9. …35	7.08
36	.495423	4.88	.658411	7.12	36	.512815	4.77	. …60	7.08
37	.495716	4.88	.658838	7.12	37	.513101	4.77	. …85	7.07
38	.496009	4.88	.659265	7.10	38	.513387	4.77	. …09	7.08
39	.496302	4.88	.659691	7.12	39	.513673	4.77	. …34	7.08
40	9.496595	4.88	9.660118	7.12	40	9.513959	4.77	9. …59	7.07
41	.496888	4.88	.660545	7.12	41	.514245	4.77	. …83	7.08
42	.497181	4.87	.660972	7.10	42	.514531	4.77	. …08	7.08
43	.497473	4.88	.661398	7.12	43	.514817	4.75	. …33	7.07
44	.497766	4.87	.661825	7.12	44	.515102	4.77	. …57	7.08
45	9.498058	4.87	9.662252	7.10	45	9.515388	4.75	9. …82	7.07
46	.498350	4.88	.662678	7.12	46	.515673	4.77	. …06	7.08
47	.498643	4.87	.663105	7.10	47	.515959	4.75	. …31	7.07
48	.498935	4.85	.663531	7.12	48	.516244	4.75	. …55	7.07
49	.499226	4.87	.663958	7.10	49	.516529	4.75	. …79	7.08
50	9.499518	4.87	9.664384	7.10	50	9.516814	4.73	9.689904	7.07
51	.499810	4.85	.664810	7.12	51	.517098	4.75	.690328	7.07
52	.500101	4.87	.665237	7.10	52	.517383	4.75	.690752	7.08
53	.500393	4.85	.665663	7.10	53	.517668	4.73	.691177	7.07
54	.500684	4.85	.666089	7.10	54	.517952	4.73	.691601	7.07
55	9.500975	4.85	9.666515	7.12	55	9.518236	4.75	9.692025	7.07
56	.501266	4.85	.666942	7.10	56	.518521	4.73	.692449	7.07
57	.501557	4.85	.667368	7.10	57	.518805	4.73	.692873	7.08
58	.501848	4.85	.667794	7.10	58	.519089	4.73	.693298	7.07
59	502139	4.83	.668220	7.10	59	.519373	4.73	.693722	7.07
60	9.502429		9.668646		60	9.519657		9.694146	

48°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.519657	4.72	[illegible]	7.07
1	.519940	4.73	[illegible]	7.07
2	.520224	4.72	[illegible]	7.07
3	.520507	4.73	[illegible]	7.07
4	.520791	4.72	[illegible]	7.07
5	9.521074	4.72	[illegible]	7.05
6	.521357	4.72	[illegible]	7.07
7	.521640	4.72	[illegible]	7.07
8	.521923	4.72	.697537	7.07
9	.522206	4.70	.697961	7.07
10	9.522488	4.72	9.698385	7.07
11	.522771	4.72	.698809	7.05
12	.523054	4.70	.699232	7.07
13	.523336	4.70	.699656	7.07
14	.523618	4.70	.700080	7.05
15	9.523900	4.70	9.700503	7.07
16	.524182	4.70	.700927	7.05
17	.524464	4.70	.701350	7.07
18	.524746	4.70	.701774	7.07
19	.525028	4.68	.702198	7.05
20	[illegible]	4.70	[illegible]	7.07
21	[illegible]	4.68	[illegible]	7.05
22	[illegible]	4.68	[illegible]	7.05
23	[illegible]	4.70	[illegible]	7.07
24	[illegible]	4.68	[illegible]	7.05
25	[illegible]	4.68	[illegible]	7.07
26	[illegible]	4.67	[illegible]	7.05
27	[illegible]	4.68	[illegible]	7.05
28	[illegible]	4.68	[illegible]	7.05
29	[illegible]	4.67	[illegible]	7.07
30	[illegible]	4.68	9.706855	7.05
31	[illegible]	4.67	.707278	7.05
32	[illegible]	4.67	.707701	7.05
33	[illegible]	4.67	.708124	7.05
34	[illegible]	4.67	.708547	7.07
35	[illegible]	4.67	9.708971	7.05
36	[illegible]	4.67	.709394	7.03
37	[illegible]	4.65	.709817	7.05
38	[illegible]	4.67	.710240	7.05
39	[illegible]	4.65	.710663	7.05
40	9.530918	4.67	9.711086	7.05
41	.531198	4.65	.711509	7.05
42	.531477	4.65	.711932	7.05
43	.531756	4.65	.712355	7.05
44	.532035	4.65	.712778	7.03
45	9.532314	4.63	9.713200	7.05
46	.532592	4.65	.713623	7.05
47	.532871	4.65	.714046	7.05
48	.533150	4.63	.714469	7.05
49	.533428	4.63	.714892	7.05
50	9.533706	4.65	9.715315	7.03
51	.533985	4.63	.715737	7.05
52	.534263	4.63	.716160	7.05
53	.534541	4.63	.716583	7.03
54	.534819	4.63	.717005	7.05
55	9.535097	4.62	9.717428	7.05
56	.535374	4.63	.717851	7.03
57	.535652	4.62	.718273	7.05
58	.535929	4.63	.718696	7.03
59	.536207	4.62	.719118	7.05
60	9.536484		9.719541	

49°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.536484	4.62	9.719541	7.05
1	.536761	4.62	.719964	7.03
2	.537038	4.62	.720386	7.05
3	.537315	4.62	.720809	7.03
4	.537592	4.62	.721231	7.03
5	9.537869	4.60	9.721653	7.05
6	.538145	4.62	.722076	7.03
7	.538422	4.60	.722498	7.05
8	.538698	4.60	.722921	7.03
9	.538974	4.62	.723343	7.03
10	9.539251	4.60	9.723765	7.05
11	.539527	4.60	.724188	7.03
12	.539803	4.60	.724610	7.03
13	.540079	4.58	.725032	7.03
14	.540354	4.60	.725454	7.05
15	9.540630	4.60	9.725877	7.03
16	.540906	4.58	.726299	7.03
17	.541181	4.58	.726721	7.03
18	.541456	4.60	.727143	7.03
19	.541732	4.58	.727565	7.05
20	9.542007	4.58	9.727988	7.03
21	.542282	4.58	.728410	7.03
22	.542557	4.58	.728832	7.03
23	.542832	4.57	.729254	7.03
24	.543106	4.58	.729676	7.03
25	9.543381	4.57	9.730098	7.03
26	.543655	4.58	.730520	7.03
27	.543930	4.57	.730942	7.03
28	.544204	4.57	.731364	7.03
29	.544478	4.57	.731786	7.03
30	9.544752	4.57	[illegible]	7.03
31	545026	4.57	[illegible]	7.03
32	.545300	4.57	[illegible]	7.03
33	.545574	4.57	[illegible]	7.03
34	.545848	4.55	[illegible]	7.02
35	9.546121	4.57	[illegible]	7.03
36	546395	4.55	[illegible]	7.03
37	.546668	4.55	[illegible]	7.03
38	.546941	4.55	[illegible]	7.03
39	.547214	4.55	[illegible]	7.03
40	[illegible]	4.55	9.736427	7.02
41	[illegible]	4.53	.736848	7.03
42	[illegible]	4.55	.737270	7.03
43	[illegible]	4.55	.737692	7.03
44	[illegible]	4.53	.738114	7.02
45	[illegible]	4.55	9.738535	7.03
46	[illegible]	4.53	.738957	7.03
47	[illegible]	4.53	.739379	7.02
48	[illegible]	4.53	.739800	7.03
49	.549940	4.53	.740222	7.03
50	9.550212	4.53	9.740644	7.02
51	.550484	4.53	.741065	7.03
52	.550756	4.53	.741487	7.02
53	.551028	4.52	.741908	7.03
54	.551299	4.53	.742330	7.02
55	9.551571	4.52	9.742751	7.03
56	.551842	4.52	.743173	7.03
57	.552113	4.52	.743595	7.02
58	.552384	4.53	.744016	7.03
59	.552656	4.52	.744438	7.02
60	9.552927		9.744859	

50°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.552927	4.50	9.744859	7.02
1	.553197	4.52	.745280	7.03
2	.553468	4.52	.745702	7.02
3	.553739	4.50	.746123	7.03
4	.554009	4.52	.746545	7.02
5	9.554280	4.50	9.746966	7.03
6	.554550	4.50	.747388	7.02
7	.554820	4.52	.747809	7.02
8	.555091	4.50	.748230	7.03
9	.555361	4.50	.748652	7.02
10	9.555631	4.48	9.749073	7.02
11	.555900	4.50	.749494	7.03
12	.556170	4.50	.749916	7.02
13	.556440	4.48	.750337	7.02
14	.556709	4.50	.750758	7.03
15	9.556979	4.48	9.751180	7.02
16	.557248	4.48	.751601	7.02
17	.557517	4.48	.752022	7.02
18	.557786	4.48	.752443	7.03
19	.558055	4.48	.752865	7.02
20	9.558324	4.48	9.753286	7.02
21	.558593	4.48	.753707	7.02
22	.558862	4.48	754128	7.02
23	.559131	4.47	.754549	7.03
24	.559399	4.47	.754971	7.02
25	9.559667	4.48	9.755392	7.02
26	.559936	4.47	755813	7.02
27	.560204	4.47	.756234	7.02
28	.560472	4.47	.756655	7.02
29	.560740	4.47	.757076	7.03
30	9. 08	4.47	9.757498	7.02
31	. 76	4.47	.757919	7.02
32	. 44	4.45	.758340	7.02
33	. 11	4.47	.758761	7.02
34	. 79	4.45	.759182	7.02
35	9. 46	4.45	9.759603	7.02
36	. 13	4.47	.760024	7.02
37	. 81	4.45	.760445	7.02
38	. 48	4.45	.760866	7.02
39	. 15	4.45	.761287	7.02
40	9. 82	4.43	9.761708	7.02
41	. 48	4.45	.762129	7.02
42	. 15	4.45	.762550	7.02
43	. 82	4.43	.762971	7.02
44	. 48	4.45	.763392	7.02
45	9. 15	4.43	9.763813	7.02
46	. 81	4.43	.764234	7.02
47	. 47	4.43	.764655	7.02
48	. 13	4.43	.765076	7.02
49	. 79	4.43	.765497	7.02
50	9. 45	4.43	9.[illegible]18	7.02
51	. 11	4.43	.[illegible]39	7.02
52	. 77	4.42	.[illegible]60	7.02
53	. 42	4.43	.[illegible]81	7.02
54	. 08	4.42	.[illegible]02	7.00
55	9. 73	4.42	9.[illegible]22	7.02
56	. 38	4.43	.[illegible]43	7.02
57	. 04	4.42	.[illegible]64	7.02
58	. 69	4.42	.[illegible]85	7.02
59	. 34	4.42	.[illegible]06	7.02
60	9. 99		9.770127	

51°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.568999	4.42	9.770127	7.02
1	.569264	4.40	.770548	7.02
2	.569528	4.42	.770969	7.00
3	.569793	4.40	.771389	7.02
4	.570057	4.42	.771810	7.02
5	9.570322	4.40	9.772231	7.02
6	.570586	4.40	.772652	7.02
7	.570850	4.40	.773073	7.02
8	.571114	4.40	.773494	7.00
9	.571378	4.40	.773914	7.02
10	9.571642	4.40	9.774335	7.02
11	.571906	4.40	.774756	7.02
12	.572170	4.40	.775177	7.02
13	.572434	4.38	.775598	7.00
14	.572697	4.38	.776018	7.02
15	9.572960	4.40	9.776439	7.02
16	.573224	4.38	.776860	7.02
17	.573487	4.38	.777281	7.02
18	.573750	4.38	.777702	7.00
19	.574013	4.38	.778122	7.02
20	9.574276	4.38	9.778543	7.02
21	.574539	4.38	.778964	7.02
22	.574802	4.37	.779385	7.00
23	.575064	4.38	.779805	7.02
24	.575327	4.37	.780226	7.02
25	9.575589	4.38	9.780647	7.02
26	.575852	4.37	.781068	7.00
27	.576114	4.37	.781488	7.02
28	.576376	4.37	.781909	7.02
29	.576638	4.37	.782330	7.02
30	9.576900	4.37	9. 51	7.00
31	.577162	4.37	. 71	7.02
32	.577424	4.35	. 92	7.02
33	.577685	4.37	. 13	7.00
34	.577947	4.35	. 33	7.02
35	9.578208	4.37	9. 54	7.02
36	.578470	4.35	. 75	7.02
37	.578731	4.35	. 96	7.00
38	.578992	4.35	. 16	7.02
39	.579253	4.35	. 37	7.02
40	9.579514	4.35	9.786958	7.00
41	.579775	4.35	787378	7.02
42	.580036	4.35	.787799	7.02
43	580297	4.33	.788220	7.02
44	.580557	4.35	.788641	7.00
45	9.580818	4.33	9.789061	7.02
46	.581078	4.35	.789482	7.02
47	.581339	4.33	.789903	7.00
48	.581599	4.33	.790323	7.02
49	.581859	4.33	.790744	7.02
50	9.582119	4.33	9.791165	7.02
51	.582379	4.33	.791586	7.00
52	.582639	4.32	.792006	7.02
53	.582898	4.33	.792427	7.02
54	583158	4.33	.792848	7.00
55	9.583418	4.32	9.793268	7.02
56	.583677	4.32	.793689	7.02
57	.583936	4.33	.794110	7.02
58	.584196	4.32	.794531	7.00
59	584455	4.32	.794951	7.02
60	9.584714		9.795372	

M				
0	9.615124	4.12	9.845905	7.03
1	.615371	4.13	.846327	7.03
2	.615619	4.13	.846749	7.02
3	.615867	4.13	.847170	7.03
4	.616115	4.12	.847592	7.03
5	9.616362	4.13	9.848014	7.03
6	.616610	4.12	.848436	7.03
7	.616857	4.12	.848858	7.03
8	.617104	4.12	.849280	7.03
9	.617351	4.12	.849702	7.03
10	9.617598	4.12	9.850124	7.03
11	.617845	4.12	.850546	7.03
12	.618092	4.12	.850968	7.03
13	.618339	4.12	.851390	7.03
14	.618586	4.12	.851812	7.03
15	9.618833	4.10	9.852234	7.03
16	.619079	4.12	.852656	7.03
17	.619326	4.10	.853078	7.03
18	.619572	4.10	.853500	7.05
19	.619818	4.12	.853923	7.03
20	9.620065	4.10	9.854345	7.03
21	.620311	4.10	.854767	7.03
22	.620557	4.10	.855189	7.05
23	.620803	4.08	.855612	7.03
24	.621048	4.10	.856034	7.03
25	9.621294	4.10	9.856456	7.03
26	.621540	4.10	.856878	7.05
27	.621786	4.08	.857301	7.03
28	.622031	4.08	.857723	7.03
29	.622276	4.10	.858145	7.05
30	9. 22	4.08	9.858568	7.03
31	. 67	4.08	.858990	7.05
32	. 12	4.08	.859413	7.03
33	. 57	4.08	.859835	7.05
34	. 02	4.08	.860258	7.03
35	9. 47	4.08	9.860680	7.05
36	. 92	4.08	.861103	7.03
37	. 37	4.07	.861525	7.05
38	. 81	4.08	.861948	7.03
39	. 26	4.07	.862370	7.05
40	9. 70	4.08	9.862793	7.03
41	. 15	4.07	.863215	7.05
42	. 59	4.07	.863638	7.05
43	. 03	4.07	.864061	7.03
44	. 47	4.07	.864483	7.05
45	9. 91	4.07	9.864906	7.05
46	. 35	4.07	.865329	7.05
47	. 79	4.07	.865752	7.03
48	. 23	4.05	.866174	7.05
49	. 66	4.07	.866597	7.05
50	9.627410	4.07	9.867020	7.05
51	.627654	4.05	.867443	7.05
52	.627897	4.05	.867866	7.05
53	.628140	4.07	.868289	7.05
54	.628384	4.05	.868712	7.05
55	9.628627	4.05	9.869135	7.05
56	.628870	4.05	.869558	7.05
57	.629113	4.05	.869981	7.05
58	.629356	4.03	.870404	7.05
59	.629598	4.05	.870827	7.05
60	9.629841		9.871250	

55°

M				'
0	9.629841	4.05	9.871250	7.05
1	.630084	4.03	.871673	7.05
2	.630326	4.05	.872096	7.05
3	.630569	4.03	.872519	7.05
4	.630811	4.05	.872942	7.07
5	9.631054	4.03	9.873366	7.05
6	.631296	4.03	.873789	7.05
7	.631538	4.03	.874212	7.07
8	.631780	4.03	.874636	7.05
9	.632022	4.03	.875059	7.05
10	9.632264	4.02	9.875482	7.07
11	.632505	4.03	.875906	7.05
12	.632747	4.03	.876329	7.05
13	.632989	4.02	.876752	7.07
14	.633230	4.03	.877176	7.05
15	9.633472	4.02	9.877599	7.07
16	.633713	4.02	.878023	7.05
17	.633954	4.03	.878446	7.07
18	.634196	4.02	.878870	7.07
19	.634437	4.02	.879294	7.05
20	9.634678	4.02	9.879717	7.07
21	.634919	4.00	.880141	7.07
22	.635159	4.02	.880565	7.05
23	.635400	4.02	.880988	7.07
24	.635641	4.00	.881412	7.07
25	9.635881	4.02	9.881836	7.07
26	.636122	4.00	.882260	7.05
27	.636362	4.02	.882683	7.07
28	.636603	4.00	.883107	7.07
29	.636843	4.00	.883531	7.07
30	9.637083	4.00	9.883955	7.07
31	.637323	4.00	.884379	7.07
32	.637563	4.00	.884803	7.07
33	.637803	4.00	.885227	7.07
34	.638043	4.00	.885651	7.07
35	9.638283	3.98	9.886075	7.07
36	.638522	4.00	.886499	7.07
37	.638762	3.98	.886923	7.07
38	.639001	4.00	.887347	7.08
39	.639241	3.98	.887772	7.07
40	9.639480	3.98	9.888196	7.07
41	.639719	3.98	.888620	7.07
42	.639958	3.98	.889044	7.08
43	.640197	3.98	.889469	7.07
44	.640436	3.98	.889893	7.07
45	9.640675	3.98	9.890317	7.08
46	.640914	3.98	.890742	7.07
47	.641153	3.97	.891166	7.08
48	.641391	3.98	.891591	7.07
49	.641630	3.97	.892015	7.08
50	9.641868	3.98	9.892440	7.07
51	.642107	3.97	.892864	7.08
52	.642345	3.97	.893289	7.08
53	.642583	3.98	.893714	7.07
54	.642822	3.97	.894138	7.08
55	9.643060	3.97	9.894563	7.08
56	.643298	3.95	.894988	7.07
57	.643535	3.97	.895412	7.08
58	.643773	3.97	.895837	7.08
59	.644011	3.97	.896262	7.08
60	9.644249		9.896687	

56°

M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.644249	3.95	9. 87	7.08
1	.644486	3.97	. 12	7.08
2	.644724	3.95	. 37	7.08
3	.644961	3.95	. 62	7.08
4	.645198	3.97	. 87	7.08
5	9.645436	3.95	9. 12	7.08
6	.645673	3.95	. 37	7.08
7	.645910	3.95	. 62	7.08
8	.646147	3.95	. 87	7.08
9	.646384	3.93	. 12	7.10
10	9.646620	3.95	9.900938	7.08
11	.646857	3.95	.901363	7.08
12	.647094	3.93	.901788	7.08
13	.647330	3.95	.902213	7.10
14	.647567	3.93	.902639	7.08
15	9.647803	3.93	9.903064	7.10
16	.648039	3.95	.903490	7.08
17	.648276	3.93	.903915	7.10
18	.648512	3.93	.904341	7.08
19	.648748	3.93	.904766	7.10
20	9.648984	3.93	9.905192	7.08
21	.649220	3.93	905617	7.10
22	.649456	3.92	.906043	7.10
23	.649691	3.93	.906469	7.08
24	.649927	3.93	906894	7.10
25	9.650163	3.92	9.907320	7.10
26	.650398	3.92	.907746	7.10
27	.650633	3.93	.908172	7.10
28	.650869	3.92	.908598	7.10
29	.651104	3.92	.909024	7.10
30	9.651339	3.92	9.909450	7.10
31	.651574	3.92	.909876	7.10
32	.651809	3.92	.910302	7.10
33	.652044	3.92	.910728	7.10
34	.652279	3.92	.911154	7.10
35	9.652514	3.90	9.911580	7.10
36	.652748	3.92	.912006	7.10
37	.652983	3.90	.912432	7.12
38	.653217	3.92	.912859	7.10
39	.653452	3.90	.913285	7.10
40	9.653686	3.90	9.913711	7.12
41	.653920	3.92	.914138	7.10
42	.654155	3.90	.914564	7.12
43	.654389	3.90	.914991	7.10
44	.654623	3.90	.915417	7.12
45	9.654857	3.88	9.915844	7.10
46	.655090	3.90	.916270	7.12
47	.655324	3.90	.916697	7.12
48	.655558	3.90	.917124	7.10
49	.655792	3.88	.917550	7.12
50	9.656025	3.88	9.917977	7.12
51	.656258	3.90	.918404	7.12
52	.656492	3.88	.918831	7.12
53	.656725	3.88	.919258	7.12
54	.656958	3.88	919685	7.12
55	9.657191	3.88	9.920112	7.12
56	.657424	3.88	.920539	7.12
57	.657657	3.88	.920966	7.12
58	.657890	3.88	.921393	7.12
59	.658123	3.88	.921820	7.12
60	9.658356		9.922247	

57°

M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9. 56	3.87	9.922247	7.12
1	. 88	3.88	.922674	7.13
2	. 21	3.87	.923102	7.12
3	. 53	3.88	.923529	7.12
4	. 86	3.87	.923956	7.13
5	9. 18	3.87	9.924384	7.12
6	. 50	3.88	.924811	7.13
7	. 83	3.87	.925239	7.12
8	. 15	3.87	.925666	7.13
9	. 47	3.87	.926094	7.12
10	9.660679	3.85	9.926521	7.13
11	.660910	3.87	.926949	7.13
12	.661142	3.87	.927377	7.12
13	661374	3.85	.927804	7.13
14	.661605	3.87	.928232	7.13
15	9.661837	3.85	9.928660	7.13
16	.662068	3.87	.929088	7.13
17	.662300	3.85	.929516	7.13
18	.662531	3.85	.929944	7.13
19	.662762	3.85	.930372	7.13
20	9. 93	3.85	9.930800	7.13
21	. 24	3.85	.931228	7.13
22	. 55	3.85	.931656	7.15
23	. 86	3.85	.932085	7.13
24	. 17	3.85	.932513	7.13
25	9. 48	3.83	9.932941	7.13
26	. 78	3.85	.933369	7.15
27	. 09	3.83	.933798	7.13
28	. 39	3.85	.934226	7.15
29	.665070	3.83	.934655	7.13
30	9.665300	3.83	9. 83	7.15
31	665530	3.83	. 12	7.15
32	.665760	3.83	. 41	7.13
33	.665990	3.83	. 69	7.15
34	.666220	3.83	. 98	7.15
35	9.666450	3.83	9. 27	7.15
36	.666680	3.83	. 56	7.15
37	.666910	3.82	. 85	7.13
38	.667139	3.83	. 13	7.15
39	.667369	3.83	. 42	7.15
40	9.667599	3.82	9.939371	7.17
41	.667828	3.82	.939801	7.15
42	.668057	3.83	.940230	7.15
43	.668287	3.82	.940659	7.15
44	.668516	3.82	.941088	7.15
45	9.668745	3.82	9.941517	7.17
46	.668974	3.82	.941947	7.15
47	.669203	3.82	.942376	7.17
48	.669432	3.82	.942806	7.15
49	.669661	3.80	.943235	7.17
50	9.669889	3.82	9.943665	7.15
51	.670118	3.82	.944094	7.17
52	.670347	3.80	.944524	7.15
53	.670575	3.82	.944953	7.17
54	.670804	3.80	.945383	7.17
55	9.671032	3.80	9.945813	7.17
56	.671260	3.80	.946243	7.17
57	.671488	3.80	.946673	7.17
58	.671716	3.82	.947103	7.17
59	671945	3.78	.947533	7.17
60	9.672172		9.947963	

58°				
M.	Vers.	D. 1".	Exsec.	D. 1".
0	9. 72	3.80	9.947963	7.17
1	. 00	3.80	.948393	7.17
2	. 28	3.80	.948823	7.17
3	. 56	3.78	.949253	7.17
4	. 83	3.80	.949683	7.18
5	9. 11	3.78	9.950114	7.17
6	. 38	3.80	.950544	7.18
7	. 66	3.78	.950975	7.17
8	. 93	3.78	.951405	7.18
9	. 20	3.80	.951836	7.17
10	9. 48	3.78	9.952266	7.18
11	. 75	3.78	.952697	7.18
12	. 02	3.78	.953128	7.17
13	. 29	3.78	.953558	7.18
14	. 56	3.77	.953989	7.18
15	9. 82	3.78	9.954420	7.18
16	. 09	3.78	.954851	7.18
17	. 36	3.77	.955282	7.18
18	. 62	3.78	.955713	7.18
19	. 89	3.77	.956144	7.18
20	9.676715	3.77	9.956575	7.18
21	.676941	3.78	.957006	7.20
22	.677168	3.77	.957438	7.18
23	.677394	3.77	.957869	7.18
24	.677620	3.77	.958300	7.20
25	9.677846	3.77	9.958732	7.18
26	.678072	3.77	.959163	7.20
27	.678298	3.75	.959595	7.18
28	.678523	3.77	.960026	7.20
29	.678749	3.77	.960458	7.20
30	9.678975	3.75	9.960890	7.18
31	.679200	3.77	.961321	7.20
32	.679426	3.75	961753	7.20
33	.679651	3.75	.962185	7.20
34	.679876	3.77	962617	7.20
35	9.680102	3.75	9.963049	7.20
36	.680327	3.75	.963481	7.20
37	.680552	3.75	963913	7.20
38	.680777	3.75	.964345	7.22
39	.681002	3.75	.964778	7.20
40	9.681227	3.73	9.965210	7.20
41	.681451	3.75	.965642	7.22
42	.681676	3.75	.966075	7.20
43	.681901	3.73	.966507	7.22
44	.682125	3.75	.966940	7.20
45	9.682350	3.73	9.967372	7.22
46	.682574	3.73	.967805	7.22
47	.682798	3.75	.968238	7.20
48	.683023	3.73	.968670	7.22
49	.683247	3.73	.969103	7.22
50	9.683471	3.73	9.969536	7.22
51	.683695	3.73	.969969	7.22
52	.683919	3.73	.970402	7.22
53	.684143	3.73	.970835	7.22
54	.684367	3.72	.971268	7.22
55	9.684590	3.73	9.971701	7.23
56	.684814	3.72	.972135	7.22
57	.685037	3.73	.972568	7.22
58	.685261	3.72	.973001	7.23
59	.685484	3.73	.973435	7.22
60	9.685708		9.973868	

0	9.685708	3.72	9.973868	7.23
1	.685931	3.72	.974302	7.23
2	.686154	3.72	.974736	7.22
3	.686377	3.72	.975169	7.23
4	.686600	3.72	.975603	7.23
5	9.686823	3.72	9.976037	7.23
6	.687046	3.72	.976471	7.23
7	.687269	3.72	.976905	7.23
8	.687492	3.70	.977339	7.23
9	.687714	3.72	.977773	7.23
10	9.687937	3.70	9.978207	7.23
11	.688159	3.72	.978641	7.23
12	.688382	3.70	.979075	7.25
13	.688604	3.70	.979510	7.33
14	.688826	3.70	.979944	7.25
15	9.689048	3.72	9.980379	7.23
16	.689271	3.70	.980813	7.25
17	.689493	3.70	.981248	7.23
18	.689715	3.70	.981682	7.25
19	.689937	3.68	.982117	7.25
20	9.690158	3.70	9.982552	7.25
21	.690380	3.70	.982987	7.25
22	.690602	3.68	.983422	7.25
23	.690823	3.70	.983857	7.25
24	691045	3.68	.984292	7.25
25	9.691266	3.70	9.984727	7.25
26	.691488	3.68	.985162	7.25
27	.691709	3.68	.985597	7.27
28	.691930	3.68	.986033	7.25
29	.692151	3.68	.986468	7.27
30	9. 72	3.68	9.986904	7.25
31	. 93	3.68	.987339	7.27
32	. 14	3.68	.987775	7.25
33	. 35	3.68	.988210	7.27
34	. 56	3.68	.988646	7.27
35	9. 77	3.67	9.989082	7.27
36	. 97	3.68	.989518	7.27
37	. 18	3.67	.989954	7.27
38	. 38	3.68	.990390	7.27
39	. 59	3.67	.990826	7.27
40	9. 79	3.67	9.991262	7.27
41	. 99	3.67	.991698	7.27
42	. 19	3.68	.992134	7.28
43	. 40	3.67	.992571	7.27
44	. 60	3.67	.993007	7.28
45	9. 80	3.65	9.993444	7.27
46	. 99	3.67	.993880	7.28
47	. 19	3.67	.994317	7.28
48	. 39	3.67	.994754	7.28
49	. 59	3.65	.995191	7.27
50	9.696778	3.67	9.995627	7.28
51	.696998	3.65	.996064	7.28
52	.697217	3.67	.996501	7.28
53	.697437	3.65	.996938	7.30
54	.697656	3.65	.997376	7.28
55	9.697875	3.65	9.997813	7.28
56	.698094	3.65	.998250	7.28
57	.698313	3.65	.998687	7.30
58	.698532	3.65	.999125	7.28
59	.698751	3.65	.999562	7.30
60	9.698970		0.000000	

60°					61°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.	M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.698970	3.65	0.000000	7.30	0	9.711968	3.57	0.026397	7.37
1	.699189	3.63	.000438	7.28	1	.712182	3.58	.026839	7.37
2	.699407	3.65	.000875	7.30	2	.712397	3.57	.027281	7.38
3	.699626	3.65	.001313	7.30	3	.712611	3.57	.027724	7.38
4	.699845	3.63	.001751	7.30	4	.712825	3.57	.028167	7.37
5	9.700063	3.65	0.002189	7.30	5	9.713039	3.57	0.028609	7.38
6	.700282	3.63	.002627	7.30	6	.713253	3.57	.029052	7.38
7	.700500	3.63	.003065	7.30	7	.713467	3.57	.029495	7.38
8	.700718	3.63	.003503	7.32	8	.713681	3.57	.029938	7.38
9	.700936	3.63	.003942	7.30	9	.713895	3.57	.030381	7.40
10	9.701154	3.63	0.004380	7.30	10	9.714109	3.57	0.030825	7.38
11	.701372	3.63	.004818	7.32	11	.714323	3.55	.031268	7.38
12	.701590	3.63	.005257	7.30	12	.714536	3.57	.031711	7.40
13	.701808	3.63	.005695	7.32	13	.714750	3.55	.032155	7.38
14	.702026	3.63	.006134	7.32	14	.714963	3.57	.032598	7.40
15	9.702244	3.63	0.006573	7.32	15	9.715177	3.55	0.033042	7.40
16	.702462	3.62	.007012	7.30	16	.715390	3.55	.033486	7.38
17	.702679	3.63	.007450	7.32	17	.715603	3.57	.033929	7.40
18	.702897	3.62	.007889	7.32	18	.715817	3.55	.034373	7.40
19	.703114	3.63	.008328	7.32	19	.716030	3.55	.034817	7.40
20	9.703332	3.62	0.008767	7.33	20	9.716243	3.55	0.035261	7.40
21	.703549	3.62	.009207	7.32	21	.716456	3.55	.035705	7.42
22	.703766	3.62	.009646	7.32	22	.716669	3.55	.036150	7.40
23	.703983	3.62	.010085	7.33	23	.716882	3.55	.036594	7.40
24	.704200	3.62	.010525	7.32	24	.717095	3.53	.037038	7.42
25	9.704417	3.62	0.010964	7.33	25	9.717307	3.55	0.037483	7.42
26	.704634	3.62	.011404	7.32	26	.717520	3.53	.037928	7.40
27	.704851	3.62	.011843	7.33	27	.717732	3.55	.038372	7.42
28	.705068	3.62	.012283	7.33	28	.717945	3.53	.038817	7.42
29	.705285	3.60	.012723	7.33	29	.718157	3.55	.039262	7.42
30	9.705501	3.62	0.013163	7.33	30	9.718370	3.53	0.039707	7.42
31	.705718	3.62	.013603	7.33	31	.718582	3.53	.040152	7.42
32	.705935	3.60	.014043	7.33	32	.718794	3.55	.040597	7.42
33	.706151	3.60	.014483	7.33	33	.719007	3.53	.041042	7.43
34	.706367	3.62	.014923	7.33	34	.719219	3.53	.041488	7.42
35	9.706584	3.60	0.015363	7.35	35	9.719431	3.53	0.041933	7.43
36	.706800	3.60	.015804	7.33	36	.719643	3.53	.042379	7.42
37	.707016	3.60	.016244	7.33	37	.719855	3.52	.042824	7.43
38	.707232	3.60	.016684	7.35	38	.720066	3.53	.043270	7.43
39	.707448	3.60	.017125	7.35	39	.720278	3.53	.043716	7.43
40	9.707664	3.60	0.017566	7.35	40	9.720490	3.52	0.044162	7.43
41	.707880	3.60	.018007	7.33	41	.720701	3.53	.044608	7.43
42	.708096	3.58	.018447	7.35	42	.720913	3.52	.045054	7.43
43	.708311	3.60	.018888	7.35	43	.721124	3.53	.045500	7.43
44	.708527	3.60	.019329	7.35	44	.721336	3.52	.045946	7.45
45	9.708743	3.58	0.019770	7.37	45	9.721547	3.52	0.046393	7.43
46	.708958	3.60	.020212	7.35	46	.721758	3.53	.046839	7.45
47	.709174	3.58	.020653	7.35	47	.721970	3.52	.047286	7.43
48	.709389	3.58	.021094	7.35	48	.722181	3.52	.047732	7.45
49	.709604	3.58	.021535	7.37	49	.722392	3.52	.048179	7.45
50	9.709819	3.60	0.021977	7.37	50	9.722603	3.52	0.048626	7.45
51	.710035	3.58	.022419	7.35	51	.722814	3.50	.049073	7.45
52	.710250	3.58	.022860	7.37	52	.723024	3.52	.049520	7.45
53	.710465	3.58	.023302	7.37	53	.723235	3.52	.049967	7.45
54	.710680	3.58	.023744	7.37	54	.723446	3.52	.050414	7.45
55	9.710895	3.57	0.024186	7.37	55	9.723657	3.50	0.050861	7.47
56	.711109	3.58	.024628	7.37	56	.723867	3.52	.051309	7.45
57	.711324	3.58	.025070	7.37	57	.724078	3.50	.051756	7.47
58	.711539	3.57	.025512	7.37	58	.724288	3.50	.052204	7.47
59	.711753	3.58	.025954	7.38	59	.724498	3.52	.052652	7.45
60	9.711968		0.026397		60	9.724709		0.053099	

			ec.	D. 1".	I				
0	9.724709		0.053099		0	9. 00		0.080153	
1	.724919	3.50	.053547	7.47	1	. 06	3.43	.080608	7.58
2	.725129	3.50	.053995	7.47	2	. 12	3.43	.081062	7.57
3	.725339	3.50	.054443	7.47	3	. 18	3.43	.081516	7.57
4	.725549	3.50	.054892	7.48	4	. 24	3.43	.081971	7.58
5	9.725759	3.50	0.055340	7.47	5	9. 30	3.43	0.082425	7.57
6	.725969	3.50	.055788	7.47	6	. 36	3.43	.082880	7.58
7	.726179	3.50	.056237	7.48	7	. 42	3.43	.083335	7.58
8	.726388	3.48	.056685	7.47	8	. 47	3.42	.083790	7.58
9	.726598	3.50	.057134	7.48	9	.739053	3.43	.084245	7.58
10	9.726808	3.50	0.057583	7.48	10	9.739258	3.42	0.084700	7.58
11	.727017	3.48	.058032	7.48	11	.739464	3.43	.085155	7.58
12	.727227	3.50	.058481	7.48	12	739669	3.42	085611	7.60
13	.727436	3.48	.058930	7.48	13	.739875	3.43	.086066	7.58
14	.727645	3.48	.059379	7.48	14	.740080	3.42	.086522	7.60
15	9.727855	3.50	0.059828	7.48	15	9.740285	3.42	0.086977	7.58
16	.728064	3.48	.060278	7.50	16	740490	3.42	087433	7.60
17	.728273	3.48	.060727	7.48	17	.740695	3.42	.087889	7.60
18	.728482	3.48	.061177	7.50	18	.740900	3.42	.088345	7.60
19	.728691	3.48	.061626	7.48	19	.741105	3.42	.088801	7.60
20	9.728900	3.48	0. 76	7.50	20	9.741310	3.42	0.089258	7.62
21	.729109	3.48	. 26	7.50	21	741515	3.42	089714	7.60
22	.729317	3.47	. 76	7.50	22	.741719	3.40	.090171	7.62
23	729526	3.48	. 26	7.50	23	.741924	3.42	.090627	7.60
24	.729735	3.48	. 76	7.50	24	.742129	3.42	.091084	7.62
25	9.729943	3.47	0. 27	7.52	25	9.742333	3.40	0.091541	7.62
26	.730152	3.48	. 77	7.50	26	.742538	3.42	.091998	7.62
27	730360	3.47	. 27	7.50	27	.742742	3.40	.092455	7.62
28	.730569	3.48	. 78	7.52	28	.742946	3.40	.092912	7.62
29	.730777	3.47	. 29	7.52	29	.743150	3.40	.093370	7.63
30	9.730985	3.47	0.066580	7.52	30	9.743355	3.42	0.093827	7.62
31	.731193	3.47	.067030	7.50	31	.743559	3.40	.094285	7.63
32	.731401	3.47	.067482	7.53	32	.743763	3.40	.094743	7.63
33	.731609	3.47	.067933	7.52	33	.743967	3.40	.095200	7.62
34	.731817	3.47	.068384	7.52	34	.744171	3.40	.095658	7.63
35	9.732025	3.47	0.068835	7.52	35	9.744375	3.40	0.096116	7.63
36	.732233	3.47	.069287	7.53	36	.744578	3.38	.096575	7.65
37	.732441	3.47	.069738	7.52	37	.744782	3.40	.097033	7.63
38	.732648	3.45	.070190	7.53	38	.744986	3.40	.097491	7.63
39	.732856	3.47	.070642	7.53	39	.745189	3.38	.097950	7.65
40	9.733064	3.47	0.071093	7.52	40	9.745393	3.40	0.098408	7.63
41	.733271	3.45	.071545	7.53	41	.745596	3.38	098867	7.65
42	.733478	3.45	.071998	7.55	42	.745800	3.40	.099326	7.65
43	.733686	3.47	.072450	7.53	43	746003	3.38	.099785	7.65
44	.733893	3.45	072902	7.53	44	.746206	3.38	.100244	7.65
45	9.734100	3.45	0.073354	7.53	45	9.746409	3.38	0.100704	7.67
46	.734307	3.45	.073807	7.55	46	.746613	3.40	101163	7.65
47	.734515	3.47	.074260	7.55	47	.746816	3.38	.101623	7.67
48	.734721	3.43	.074712	7.53	48	.747019	3.38	.102082	7.65
49	.734928	3.45	.075165	7.55	49	.747222	3.38	.102542	7.67
50	9.735135	3.45	0.075618	7.55	50	9.747424	3.37	0.103002	7.67
51	.735342	3.45	.076071	7.55	51	.747627	3.38	.103462	7.67
52	.735549	3.45	.076524	7.55	52	.747830	3.38	.103922	7.67
53	.735755	3.43	.076977	7.55	53	.748033	3.38	.104382	7.67
54	.735962	3.45	.077431	7.57	54	.748235	3.37	.104843	7.68
55	9.736169	3.45	0.077884	7.55	55	9.748438	3.38	0.105303	7.67
56	.736375	3.43	.078338	7.57	56	.748640	3.37	.105764	7.68
57	.736581	3.43	.078792	7.57	57	.748843	3.38	.106224	7.67
58	.736788	3.45	.079245	7.55	58	749045	3.37	.106685	7.68
59	.736994	3.43	.079699	7.57	59	.749247	3.37	.107146	7.68
60	9.737200	3.43	0.080153	7.57	60	9.749449	3.37	0.107607	7.68

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0	9.749449	3.38	0.107607	7.70
1	.749652	3.37	.108069	7.68
2	749854	3.37	.108530	7.70
3	.750056	3.37	.108992	7.68
4	.750258	3.35	.109453	7.70
5	9.750459	3.37	0.109915	7.70
6	750661	3.37	.110377	7.70
7	.750863	3.37	.110839	7.70
8	.751065	3.35	.111301	7.70
9	.751266	3.37	111763	7.72
10	9.751468	3.35	0.112226	7.70
11	.751669	3.37	112688	7.72
12	.751871	3.35	.113151	7.72
13	.752072	3.35	.113614	7.72
14	.752273	3.37	.114077	7.72
15	9.752475	3.35	0.114540	7.72
16	.752676	3.35	.115003	7.72
17	.752877	3.35	.115466	7.72
18	.753078	3.35	.115929	7.73
19	.753279	3.35	.116393	7.73
20	9.753480	3.35	0.116857	7.73
21	.753681	3.33	.117321	7.73
22	.753881	3.35	.117785	7.73
23	.754082	3.35	.118249	7.73
24	.754283	3.33	.118713	7.73
25	9.754483	3.35	0.119177	7.75
26	.754684	3.33	.119642	7.73
27	.754884	3.35	.120106	7.75
28	.755085	3.33	.120571	7.75
29	.755285	3.33	.121036	7.75
30	9.755485	3.33	0.121501	7.75
31	755685	3.35	.121966	7.75
32	.755886	3.33	.122431	7.77
33	.756086	3.33	.122897	7.75
34	.756286	3.33	.123362	7.77
35	9.756486	3.32	0.123828	7.77
36	.756685	3.33	.124294	7.77
37	.756885	3.33	.124760	7.77
38	.757085	3.33	.125226	7.77
39	.757285	3.32	.125692	7.77
40	9.757484	3.33	0.126158	7.78
41	.757684	3.32	.126625	7.78
42	.757883	3.33	.127092	7.77
43	.758083	3.32	.127558	7.78
44	.758282	3.32	.128025	7.78
45	9.758481	3.33	0.128492	7.80
46	.758681	3.32	.128960	7.78
47	.758880	3.32	.129427	7.78
48	.759079	3.32	.129894	7.80
49	.759278	3.32	.130362	7.80
50	9.759477	3.32	0.130830	7.80
51	.759676	3.32	.131298	7.80
52	.759875	3.30	.131766	7.80
53	.760073	3.32	.132234	7.80
54	.760272	3.32	.132702	7.80
55	9.760471	3.30	0.133170	7.82
56	.760669	3.32	.133639	7.82
57	.760868	3.30	.134108	7.82
58	.761066	3.32	.134577	7.82
59	.761265	3.30	.135046	7.82
60	9.761463		0.135515	

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				″.
0	9.761463	3.30	0.135515	7.82
1	.761661	3.32	.135984	7.83
2	.761860	3.30	.136454	7.82
3	.762058	3.30	.136923	7.83
4	.762256	3.30	.137393	7.83
5	9.762454	3.30	0.137863	7.83
6	.762652	3.30	.138333	7.83
7	.762850	3.28	.138803	7.83
8	.763047	3.30	.139273	7.85
9	.763245	3.30	.139744	7.83
10	9. 43	3.30	0.140214	85
11	41	3.28	.140685	85
12	38	3.30	.141156	85
13	. 36	3.28	.141627	85
14	33	3.28	.142098	85
15	9. 30	3.30	0.142569	87
16	. 28	3.28	.143041	85
17	. 25	3.28	.143512	87
18	22	3.28	.143984	87
19	. 19	3.28	.144456	87
20	9.765416	3.28	0.144928	7.87
21	.765613	3.28	.145400	7.87
22	.765810	3.28	.145872	7.88
23	.766007	3.28	.146345	7.88
24	.766204	3.28	.146818	7.87
25	9.766401	3.27	0.147290	7.88
26	.766597	3.28	.147763	7.88
27	.766794	3.28	.148236	7.90
28	.766991	3.27	.148710	7.88
29	.767187	3.28	.149183	7.90
30	9.767384	3.27	0.149657	7.88
31	.767580	3.27	.150130	7.90
32	.767776	3.27	.150604	7.90
33	767972	3.28	.151078	7.90
34	.768169	3.27	.151552	7.92
35	9.768365	3.27	0.152027	7.90
36	.768561	3.27	.152501	7.92
37	.768757	3.27	.152976	7.90
38	.768953	3.27	.153450	7.92
39	.769149	3.25	.153925	7.92
40	9.769344	3.27	0.154400	7.93
41	.769540	3.27	.154876	7.92
42	.769736	3.25	.155351	7.92
43	.769931	3.27	.155826	7.93
44	.770127	3.27	.156302	7.93
45	9.770323	3.25	0.156778	7.93
46	.770518	3.25	.157254	7.93
47	.770713	3.27	.157730	7.93
48	.770909	3.25	.158206	7.95
49	.771104	3.25	.158683	7.93
50	9.771299	3.25	0.159159	7.95
51	.771494	3.25	.159636	7.95
52	.771689	3.25	.160113	7.95
53	.771884	3.25	.160590	7.95
54	.772079	3.25	.161067	7.97
55	9.772274	3.25	0.161545	7.95
56	.772469	3.25	.162022	7.97
57	.772664	3.23	.162500	7.97
58	.772858	3.25	.162978	7.97
59	.773053	3.25	.163456	7.97
60	9.773248		0.163934	

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0	9.773248	3.23	0.163934	7.98	0	9. 09	3.18	0.192931	8.15
1	.773442	3.23	.164413	7.97	1	. 00	3.18	.193420	8.13
2	.773636	3.25	.164891	7.98	2	. 91	3.17	.193908	8.15
3	.773831	3.23	.165370	7.98	3	. 81	3.18	.194397	8.15
4	.774025	3.23	.165849	7.98	4	. 72	3.18	.194886	8.17
5	9.774219	3.25	0.166328	7.98	5	9. 63	3.17	0.195376	8.15
6	.774414	3.23	.166807	7.98	6	. 53	3.18	.195865	8.17
7	.774608	3.23	.167286	8.00	7	. 44	3.17	.196355	8.17
8	.774802	3.23	167766	7.98	8	. 34	3.17	.196845	8.17
9	.774996	3.23	.168245	8.00	9	. 24	3.18	.197335	8.17
10	9.775190	3.23	0.168725	8.00	10	9.786715	3.17	0.197825	8.17
11	.775384	3.22	.169205	8.00	11	.786905	3.17	.198315	8.18
12	.775577	3.23	.169685	8.00	12	787095	3.17	.198806	8.18
13	.775771	3.23	.170165	8.02	13	.787285	3.17	.199297	8.18
14	.775965	3.23	.170646	8.02	14	.787475	3.17	199788	8.18
15	9.776159	3.22	0.171127	8.00	15	9.787665	3.17	0.200279	8.18
16	.776352	3.23	.171607	8.02	16	.787855	3.17	.200770	8.20
17	.776546	3.22	.172088	8.02	17	.788045	3.17	.201262	8.18
18	.776739	3.23	.172569	8.03	18	788235	3.17	201753	8.20
19	.776933	3.22	.173051	8.02	19	.788425	3.15	.202245	8.20
20	9.777126	3.22	0.173532	8.03	20	9.788614	3.17	0.202737	8.20
21	.777319	3.22	.174014	8.03	21	.788804	3.15	.203229	8.22
22	.777512	3.22	.174496	8.03	22	.788993	3.17	.203722	8.22
23	.777705	3.23	.174978	8.03	23	.789183	3.15	.204215	8.20
24	.777899	3.22	.175460	8.03	24	789372	3.17	.204707	8.22
25	9.778092	3.22	0.175942	8.05	25	9.789562	3.15	0.205200	8.23
26	.778285	3.20	.176425	8.03	26	789751	3.15	.205694	8.22
27	.778477	3.22	.176907	8.05	27	.789940	3.17	.206187	8.23
28	778670	3.22	.177390	8.05	28	.790130	3.15	.206681	8.22
29	.778863	3.22	.177873	8.05	29	.790319	3.15	.207174	8.23
30	9. 56	3.20	0.178356	8.05	30	9.790508	3.15	0.207668	8.23
31	. 48	3.22	.178839	8.07	31	790697	3.15	.208162	8.25
32	. 41	3.22	.179323	8.07	32	.790886	3.15	.208657	8.23
33	. 34	3.20	.179807	8.05	33	791075	3.15	.209151	8.25
34	. 26	3.20	.180290	8.07	34	.791264	3.15	.209646	8.25
35	9. 18	3.22	0.180774	8.08	35	9.791453	3.13	0.210141	8.25
36	. 11	3.20	.181259	8.07	36	.791641	3.15	.210636	8.25
37	. 03	3.20	181743	8.07	37	791830	3.15	.211131	8.27
38	. 95	3.20	.182227	8.08	38	.792019	3.13	.211627	8.27
39	. 87	3.22	.182712	8.08	39	792207	3.15	.212123	8.25
40	9. 80	3.20	0.183197	8.08	40	9.792396	3.13	0.212618	8.28
41	. 72	3.20	.183682	8.08	41	792584	3.13	.213115	8.27
42	. 64	3.20	.184167	8.10	42	.792772	3.15	.213611	8.27
43	. 56	3.18	.184653	8.08	43	.792961	3.13	.214107	8.28
44	. 47	3.20	.185138	8.10	44	793149	3.13	.214604	8.28
45	9. 39	3.20	0.185624	8.10	45	9.793337	3.13	0.215101	8.28
46	. 31	3.20	.186110	8.10	46	.793525	3.15	.215598	8.28
47	. 23	3.18	.186596	8.10	47	793714	3.13	.216095	8.30
48	. 14	3.20	.187082	8.10	48	.793902	3.13	.216593	8.28
49	. 06	3.18	.187568	8.12	49	.794090	3.12	.217090	8.30
50	9. 97	3.20	0.188055	8.12	50	9.794277	3.13	0.217588	8.30
51	. 89	3.18	.188542	8.12	51	.794465	3.13	.218086	8.32
52	. 80	3.18	.189029	8.12	52	.794653	3.13	.218585	8.30
53	. 71	3.20	.189516	8.12	53	.794841	3.12	.219083	8.32
54	. 63	3.18	.190003	8.13	54	.795028	3.13	.219582	8.32
55	9. 54	3.18	0.190491	8.12	55	9.795216	3.13	0.220081	8.32
56	. 45	3.18	.190978	8.13	56	.795404	3.12	.220580	8.32
57	. 36	3.18	.191466	8.13	57	.795591	3.13	.221079	8.32
58	. 27	3.18	.191954	8.15	58	.795779	3.12	.221578	8.33
59	. 18	3.18	.192443	8.13	59	.795966	3.12	.222078	8.33
60	9. 09		0.192931		60	9.796153		0.222578	

68°

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0	9.796153	3.13	0.222578	8.33	0	9. 86	3.07	0.252957	8.55
1	.796341	3.12	.223078	8.33	1	. 70	3.07	.253470	8.55
2	.796528	3.12	.223578	8.35	2	. 54	3.05	253983	8.57
3	.796715	3.12	.224079	8.33	3	. 37	3.07	.254497	8.55
4	.796902	3.12	.224579	8.35	4	. 21	3.05	255010	8.57
5	9.797089	3.12	0.225080	8.35	5	9. 04	3.07	0.255524	8.58
6	.797276	3.12	.225581	8.37	6	. 88	3.05	.256039	8.57
7	.797463	3.12	.226083	8.35	7	. 71	3.07	.256553	8.58
8	.797650	3.12	.226584	8.37	8	. 55	3.05	.257068	8.57
9	.797837	3.10	.227086	8.37	9	. 38	3.05	.257582	8.60
10	9.798023	3.12	0.227588	8.37	10	9.809121	3.07	0.258098	8.58
11	.798210	3.12	.228090	8.37	11	.809305	3.05	.258613	8.60
12	.798397	3.10	.228592	8.38	12	.809488	3.05	.259129	8.58
13	.798583	3.12	.229095	8.38	13	.809671	3.05	.259644	8.60
14	.798770	3.10	.229598	8.38	14	.809854	3.05	.260160	8.62
15	9.798956	3.10	0.230101	8.38	15	9.810037	3.05	0.260677	8.60
16	.799142	3.12	.230604	8.38	16	.810220	3.05	261193	8.62
17	.799329	3.10	.231107	8.40	17	.810403	3.03	.261710	8.62
18	.799515	3.10	.231611	8.40	18	.810585	3.05	.262227	8.62
19	.799701	3.10	.232115	8.40	19	.810768	3.05	.262744	8.63
20	9.799887	3.12	0.232619	8.40	20	9.810951	3.05	0.263262	8.62
21	.800074	3.10	.233123	8.40	21	.811134	3.03	.263779	8.63
22	.800260	3.10	.233627	8.42	22	.811316	3.05	.264297	8.63
23	.800446	3.08	.234132	8.42	23	.811499	3.03	.264815	8.65
24	.800631	3.10	.234637	8.42	24	.811681	3.05	.265334	8.65
25	9.800817	3.10	0.235142	8.42	25	9.811864	3.03	0.265853	8.63
26	.801003	3.10	.235647	8.43	26	.812046	3.03	.266371	8.67
27	.801189	3.10	.236153	8.42	27	.812228	3.03	.266891	8.65
28	.801375	3.08	.236658	8.43	28	.812410	3.05	.267410	8.67
29	.801560	3.10	.237164	8.43	29	.812593	3.03	.267930	8.65
30	9. 46	3.08	0.237670	8.45	30	9.812775	3.03	0.268449	8.68
31	. 31	3.10	.238177	8.43	31	.812957	3.03	.268970	8.67
32	. 17	3.08	.238683	8.45	32	.813139	3.03	.269490	8.68
33	. 02	3.08	.239190	8.45	33	.813321	3.03	.270011	8.67
34	. 87	3.10	.239697	8.45	34	.813503	3.03	.270531	8.68
35	9. 73	3.08	0.240204	8.47	35	9.813685	3.02	0.271052	8.70
36	. 58	3.08	.240712	8.45	36	.813866	3.03	.271574	8.68
37	. 43	3.08	.241219	8.47	37	.814048	3.03	.272095	8.70
38	. 28	3.08	.241727	8.47	38	.814230	3.02	.272617	8.70
39	. 13	3.08	.242235	8.48	39	.814411	3.03	.273139	8.72
40	9. 98	3.08	0.242744	8.47	40	9. 93	3.03	0.273662	8.70
41	. 83	3.08	.243252	8.48	41	. 75	3.02	.274184	8.72
42	. 68	3.08	.243761	8.48	42	. 56	3.02	.274707	8.72
43	. 53	3.08	.244270	8.48	43	. 37	3.03	.275230	8.72
44	. 38	3.07	.244779	8.50	44	. 19	3.02	.275753	8.73
45	9. 22	3.08	0.245289	8.48	45	9. 00	3.02	0.276277	8.73
46	. 07	3.08	.245798	8.50	46	. 81	3.02	.276801	8.73
47	. 92	3.07	.246308	8.50	47	. 62	3.03	.277325	8.73
48	.805076	3.08	.246818	8.52	48	. 44	3.02	.277849	8.75
49	.805261	3.07	.247329	8.50	49	. 25	3.02	.278374	8.75
50	9. 45	3.07	0.247839	8.52	50	9. 06	3.02	0.278899	8.75
51	. 29	3.08	.248350	8.52	51	. 87	3.00	.279424	8.75
52	. 14	3.07	.248861	8.52	52	. 67	3.02	.279949	8.77
53	. 98	3.07	.249372	8.52	53	. 48	3.02	.280475	8.75
54	. 82	3.07	.249883	8.53	54	. 29	3.02	.281000	8.78
55	9. 66	3.07	0.250395	8.53	55	9. 10	3.00	0.281527	8.77
56	. 50	3.07	.250907	8.53	56	. 90	3.02	.282053	8.78
57	. 34	3.07	.251419	8.55	57	. 71	3.02	.282580	8.77
58	. 18	3.07	.251932	8.53	58	. 52	3.00	.283106	8.80
59	. 02	3.07	.252444	8.55	59	. 32	3.02	283634	8.78
60	9. 86		0.252957		60	9. 13		0.284161	

70°									
M.	Vers.	D. 1″.	Exsec.	D. 1″.					″.
0	9.818213	3.00	0.284161	8.80	0	9.828938	2.95	0.316296	9.07
1	.818393	3.00	.284689	8.78	1	.829115	2.95	.316840	9.08
2	.818573	3.02	.285216	8.82	2	.829292	2.95	.317385	9.07
3	.818754	3.00	.285745	8.80	3	.829469	2.95	.317929	9.10
4	.818934	3.00	.286273	8.82	4	829646	2.95	.318475	9.08
5	9.819114	3.00	0.286802	8.82	5	9.829823	2.95	0.319020	9.08
6	.819294	3.00	.287331	8.82	6	.830000	2.95	.319565	9.10
7	.819474	3.00	.287860	8.82	7	.830177	2.93	.320111	9.12
8	.819654	3.00	.288389	8.83	8	.830353	2.95	.320658	9.10
9	.819834	3.00	.288919	8.83	9	.830530	2.93	.321204	9.12
10	9.820014	3.00	0.289449	8.83	10	9. 06	2.95	0. 51	9.12
11	.820194	3.00	.289979	8.85	11	. 83	2.93	. 98	9.12
12	.820374	2.98	.290510	8.85	12	. 59	2.95	. 45	9.13
13	.820553	3.00	.291041	8.85	13	. 36	2.93	. 93	9.13
14	.820733	3.00	.291572	8.85	14	. 12	2.95	. 41	9.13
15	9.820913	2.98	0.292103	8.87	15	9. 89	2.93	0. 89	9.15
16	.821092	3.00	.292635	8.85	16	. 65	2.93	. 38	9.15
17	.821272	2.98	.293166	8.87	17	. 41	2.93	. 87	9.15
18	.821451	3.00	.293698	8.88	18	. 17	2.93	. 36	9.17
19	.821631	2.98	.294231	8.88	19	. 93	2.93	. 86	9.15
20	9.821810	2.98	0.294764	8.87	20	9. 69	2.93	0.327235	9.18
21	. 89	2.98	.295296	8.90	21	. 45	2.93	.327786	9.17
22	. 68	3.00	.295830	8.88	22	. 21	2.93	.328336	9.18
23	. 48	2.98	.296363	8.90	23	. 97	2.93	.328887	9.18
24	. 27	2.98	.296897	8.90	24	. 73	2.93	.329438	9.18
25	9. 06	2.98	0.297431	8.90	25	9. 49	2.93	0.329989	9.20
26	. 85	2.98	.297965	8.92	26	. 25	2.92	.330541	9.20
27	. 64	2.98	.298500	8.90	27	. 00	2.93	.331093	9.20
28	. 43	2.97	.299034	8.93	28	. 76	2.92	.331645	9.22
29	. 21	2.98	.299570	8.92	29	. 51	2.93	.332198	9.20
30	9.823600	2.98	0.300105	8.93	30	9.834227	2.92	0.332750	9.23
31	.823779	2.98	.300641	8.92	31	.834402	2.93	.333304	9.22
32	.823958	2.97	.301176	8.95	32	.834578	2.92	.333857	9.23
33	.824136	2.98	.301713	8.93	33	.834753	2.92	.334411	9.23
34	.824315	2.97	.302249	8.95	34	.834928	2.93	.334965	9.25
35	9.824493	2.98	0.302786	8.95	35	9.835104	2.92	0.335520	9.23
36	.824672	2.97	.303323	8.95	36	.835279	2.92	.336074	9.25
37	.824850	2.97	.303860	8.97	37	.835454	2.92	.336629	9.27
38	.825028	2.98	.304398	8.97	38	.835629	2.92	.337185	9.27
39	.825207	2.97	.304936	8.97	39	.835804	2.92	.337741	9.27
40	9. 85	2.97	0.305474	8.97	40	9.835979	2.92	0.338297	9.27
41	. 63	2.97	.306012	8.98	41	836154	2.92	.338853	9.28
42	. 41	2.97	.306551	8.98	42	.836329	2.92	.339410	9.28
43	. 19	2.97	.307090	8.98	43	836504	2.90	.339967	9.28
44	. 97	2.97	.307629	9.00	44	.836678	2.92	.340524	9.30
45	9. 75	2.97	0.308169	8.98	45	9.836853	2.92	0.341082	9.30
46	. 53	2.97	.308708	9.02	46	.837028	2.90	.341640	9.30
47	. 31	2.97	.309249	9.00	47	.837202	2.92	.342198	9.30
48	. 09	2.97	.309789	9.02	48	.837377	2.90	.342756	9.32
49	. 87	2.95	.310330	9.02	49	837551	2.92	.343315	9.33
50	9.827164	2.97	0.310871	9.02	50	9.837726	2.90	0.343875	9.32
51	.827342	2.95	.311412	9.02	51	837900	2.92	.344434	9.33
52	.827519	2.97	.311953	9.03	52	.838075	2.90	.344994	9.33
53	.827697	2.95	.312495	9.03	53	.838249	2.90	.345554	9.35
54	.827874	2.97	.313037	9.05	54	.838423	2.90	.346115	9.35
55	9.828052	2.95	0.313580	9.03	55	9.838597	2.90	0.346676	9.35
56	.828229	2.95	.314122	9.05	56	.838771	2.90	.347237	9.35
57	.828406	2.97	.314665	9.07	57	.838945	2.90	.347798	9.37
58	.828584	2.95	.315209	9.05	58	.839119	2.90	.348360	9.37
59	.828761	2.95	.315752	9.07	59	.839293	2.90	.348922	9.38
60	9.828938		0.316296		60	9.839467		0.349485	

	Vers.	D. 1".	Exsec.	D. 1"						".
0	9. 67	2.90	0.349485	9.38	0	9. 05	2.85	0. 70		
1	. 41	2.90	.350048	9.38	1	. 76	2.85	. 54		
2	. 15	2.90	.350611	9.40	2	. 47	2.83	. 38		
3	. 89	2.88	.351175	9.38	3	. 17	2.85	. 23		
4	. 62	2.90	351738	9.42	4	. 88	2.83	. 09		
5	9. 36	2.90	0.352303	9.40	5	9. 58	2.85	0. 94		
6	. 10	2.88	352867	9.42	6	. 29	2.83	. 80		
7	. 83	2.90	.353432	9.42	7	. 99	2.83	. 67		
8	. 57	2.88	353997	9.43	8	. 69	2.85	. 54		
9	.841030	2.90	.354563	9.43	9	. 40	2.83	. 41		
10	9.841204	2.88	0.355129	9.43	10	9.851510	2.83	0.389728		
11	.841377	2.88	.355696	9.43	11	.851680	2.83	.390316		
12	.841550	2.88	.356261	9.45	12	.851850	2.83	.390905		
13	.841723	2.88	.356828	9.45	13	.852020	2.83	.391493		
14	.841896	2.90	.357395	9.47	14	.852190	2.83	.392082		
15	9.842070	2.88	0.357963	9.47	15	9.852360	2.83	0.392672		
16	.842243	2.88	.358531	9.47	16	.852530	2.83	.393262		
17	.842416	2.88	.359099	9.48	17	.852700	2.83	.393852		
18	.842589	2.88	.359668	9.48	18	.852870	2.83	.394443		
19	.842762	2.87	.360237	9.48	19	.853040	2.82	.395034		
20	9. 34	2.88	0.360806	9.50	20	9.853209	2.83	0.395625		
21	. 07	2.88	.361376	9.50	21	.853379	2.83	.396217		
22	. 80	2.88	.361946	9.50	22	.853549	2.82	.396809		
23	. 53	2.87	.362516	9.52	23	.853718	2.83	.397402		
24	. 25	2.88	.363087	9.52	24	.853888	2.82	.397995		
25	9. 98	2.87	0.363658	9.52	25	9.854057	2.83	0.398589		
26	. 70	2.88	.364229	9.53	26	.854227	2.82	.399182		
27	. 43	2.87	.364801	9.53	27	.854396	2.82	.399777		
28	. 15	2.88	.365373	9.53	28	.854565	2.83	.400371		
29	. 88	2.87	.365945	9.55	29	.854735	2.82	.400966		
30	9.844660	2.87	0.366518	9.55	30	9.854904	2.82	0.401562		
31	.844832	2.87	.367091	9.57	31	.855073	2.82	.402158		
32	. 04	2.88	.367665	9.57	32	.855242	2.82	.402754		
33	. 77	2.87	.368239	9.57	33	.855411	2.82	403351		
34	. 49	2.87	.368813	9.57	34	.855580	2.82	.403948		
35	9. 21	2.87	0.369387	9.58	35	9.855749	2.82	0.404545		
36	. 93	2.87	369962	9.60	36	.855918	2.82	.405143		
37	. 65	2.87	.370538	9.58	37	.856087	2.80	.405742		
38	. 37	2.85	.371113	9.60	38	.856255	2.82	.406340		
39	. 08	2.87	.371689	9.62	39	.856424	2.82	.406939		
40	9.846380	2.87	0.372266	9.60	40	9. 93	2.82	0.407539		
41	.846552	2.87	.372842	9.62	41	. 62	2.80	.408139		
42	.846724	2.85	.373419	9.63	42	. 30	2.82	.408739		
43	.846895	2.87	.373997	9.63	43	. 99	2.80	.409340		
44	.847067	2.85	.374575	9.63	44	. 67	2.82	.409941		
45	9.847238	2.87	0.375153	9.63	45	9. 36	2.80	0.410543		
46	.847410	2.85	.375731	9.65	46	. 04	2.80	.411145		
47	.847581	2.87	.376310	9.67	47	. 72	2.82	.411747		
48	.847753	2.85	.376890	9.65	48	. 41	2.80	.412350		10.07
49	.847924	2.85	.377469	9.67	49	. 09	2.80	.412954		10.05
50	9.848095	2.87	0.378049	9.68	50	9.858277	2.80	0.413557		10.07
51	.848267	2.85	.378630	9.67	51	.858445	2.80	.414161		10.08
52	.848438	2.85	.379210	9.70	52	.858613	2.80	.414766		10.08
53	.848609	2.85	.379792	9.68	53	858781	2.80	.415371		10.08
54	.848780	2.85	.380373	9.70	54	.858949	2.80	.415976		10.10
55	9.848951	2.85	0.380955	9.70	55	9.859117	2.80	0.416582		10.12
56	.849122	2.85	.381537	9.72	56	.859285	2.80	.417189		10.10
57	.849293	2.85	.382120	9.72	57	.859453	2.80	.417795		10.12
58	.849464	2.83	.382703	9.72	58	.859621	2.78	.418402		10.13
59	.849634	2.85	.383286	9.73	59	.859788	2.80	.419010		10.13
60	9.849805		0.383870		60	9.859956		0.419618		

0	9.859956	2.80	0.419618	10.13
1	.860124	2.78	.420226	10.15
2	.860291	2.80	.420835	10.17
3	.860459	2.78	.421445	10.15
4	.860626	2.80	.422054	10.17
5	9.860794	2.78	0.422664	10.18
6	.860961	2.78	.423275	10.18
7	.861128	2.80	.423886	10.20
8	.861296	2.78	.424498	10.20
9	.861463	2.78	.425110	10.20
10	9.861630	2.78	0.425722	10.22
11	.861797	2.78	.426335	10.22
12	.861964	2.78	.426948	10.23
13	.862131	2.78	.427562	10.23
14	.862298	2.78	.428176	10.23
15	9.862465	2.78	0.428790	10.27
16	.862632	2.78	.429406	10.25
17	.862799	2.77	.430021	10.27
18	.862965	2.78	.430637	10.27
19	.863132	2.78	.431253	10.28
20	9.863299	2.77	0.431870	10.30
21	.863465	2.78	.432488	10.28
22	.863632	2.78	.433105	10.34
23	.863799	2.77	.433724	10.30
24	.863965	2.77	.434342	10.32
25	9.864131	2.78	0.434961	10.33
26	.864298	2.77	.435581	10.33
27	.864464	2.77	.436201	10.33
28	.864630	2.78	.436821	10.35
29	.864797	2.77	.437442	10.37
30	9.864963	2.77	0.438064	10.37
31	.865129	2.77	.438686	10.37
32	.865295	2.77	.439308	10.38
33	.865461	2.77	.439931	10.38
34	.865627	2.77	.440554	10.40
35	9.865793	2.77	0.441178	10.40
36	.865959	2.75	.441802	10.42
37	.866124	2.77	.442427	10.42
38	.866290	2.77	.443052	10.43
39	.866456	2.77	.443678	10.43
40	9.866622	2.75	0.444304	10.45
41	.866787	2.77	.444931	10.45
42	.866953	2.75	.445558	10.45
43	.867118	2.77	.446185	10.47
44	.867284	2.75	.446813	10.48
45	9.867449	2.75	0.447442	10.48
46	.867614	2.77	.448071	10.48
47	.867780	2.75	.448700	10.50
48	.867945	2.75	.449330	10.52
49	.868110	2.75	.449961	10.52
50	9.868275	2.75	0.450592	10.52
51	.868440	2.77	.451223	10.53
52	.868606	2.75	.451855	10.53
53	.868771	2.75	.452487	10.55
54	.868936	2.73	.453120	10.57
55	9.869100	2.75	0.453754	10.57
56	.869265	2.75	.454388	10.57
57	.869430	2.75	.455022	10.58
58	869595	2.75	.455657	10.58
59	.869760	2.73	.456292	10.60
60	9.869924		0.456928	

75°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9. 24	2.75	0. 28	10.60
1	. 89	2.73	. 64	10.62
2	. 53	2.75	. 01	10.63
3	. 18	2.73	. 39	10.62
4	. 82	2.75	. 76	10.65
5	9. 47	2.73	0. 15	10.65
6	. 11	2.75	. 54	10.65
7	. 76	2.73	. 93	10.67
8	. 40	2.73	. 33	10.67
9	. 04	2.73	. 73	10.68
10	9. 68	2.73	0. 14	10.70
11	. 32	2.73	. 56	10.70
12	. 96	2.73	. 98	10.70
13	. 60	2.73	. 40	10.72
14	. 24	2.73	. 83	10.73
15	9. 88	2.73	0. 27	10.73
16	. 52	2.73	. 71	10.73
17	. 16	2.73	. 15	10.75
18	. 80	2.72	. 60	10.77
19	. 43	2.73	. 06	10.77
20	9. 07	2.73	0.469752	10.77
21	. 71	2.72	.470398	10.78
22	. 34	2.73	.471045	10.80
23	. 98	2.72	.471693	10.80
24	. 61	2.73	.472341	10.82
25	9. 25	2.72	0.472990	10.82
26	. 88	2.72	.473639	10.83
27	. 51	2.73	.474289	10.83
28	. 15	2.72	.474939	10.85
29	. 78	2.72	.475590	10.87
30	9. 41	2.72	0. 42	10.85
31	. 04	2.72	. 93	10.88
32	. 67	2.72	. 46	10.88
33	. 30	2.72	. 99	10.88
34	. 93	2.72	. 52	10.90
35	9. 56	2.72	0. 06	10.92
36	. 19	2.72	. 61	10.92
37	. 82	2.72	. 16	10.93
38	. 45	2.72	. 72	10.93
39	. 08	2.70	. 28	10.95
40	9. 70	2.72	0. 85	10.95
41	. 33	2.72	. 42	10.97
42	. 96	2.70	. 00	10.98
43	. 58	2.72	. 59	10.98
44	. 21	2.70	. 18	10.98
45	9. 83	2.70	0. 77	11.02
46	. 45	2.72	. 38	11.00
47	. 08	2.70	. 98	11.02
48	. 70	2.70	. 59	11.03
49	. 32	2.72	. 21	11.05
50	9.878095	2.70	0.489384	11.05
51	.878257	2.70	.490047	11.05
52	.878419	2.70	.490710	11.07
53	.878581	2.70	.491374	11.08
54	.878743	2.70	.492039	11.08
55	9.878905	2.70	0.492704	11.10
56	.879067	2.70	.493370	11.10
57	.879229	2.68	.494036	11.12
58	.879390	2.70	.494703	11.13
59	.879552	2.70	.495371	11.13
60	9.879714		0.496039	

78°					79°				
M.	Vers.	D. 1".	Exsec.	D. 1".	M.	Vers.	D. 1".	Exsec.	D. 1".
0	9. 74	2.60	0.580895	12.50	0	9.908051	2.55	0.627452	13.40
1	. 30	2.60	.581645	12.53	1	.908204	2.55	.628256	13.40
2	. 86	2.58	.582397	12.53	2	.908357	2.57	.629060	13.43
3	. 41	2.60	.583149	12.57	3	.908511	2.55	.629866	13.45
4	. 97	2.60	.583903	12 57	4	.908664	2.55	.630673	13.45
5	9. 53	2.60	0.584657	12.57	5	9.908817	2.55	0.631480	13.48
6	. 09	2.60	.585411	12.60	6	.908970	2.55	.632289	13.48
7	. 65	2.58	.586167	12.60	7	.909123	2.55	.633098	13.52
8	. 20	2.60	.586923	12.63	8	.909276	2.53	.633909	13.52
9	. 76	2.58	.587681	12.63	9	.909428	2.55	.634720	13.55
10	9.900331	2.60	0.588439	12.65	10	9.909581	2.55	0. 33	13.55
11	.900487	2.58	.589198	12.65	11	.909734	2.55	. 46	13.58
12	.900642	2.60	.589957	12.68	12	.909887	2.53	. 61	13.58
13	.900798	2.58	.590718	12.68	13	.910039	2.55	. 76	13.60
14	.900953	2.58	.591479	12.72	14	.910192	2.55	. 92	13.63
15	9.901108	2.60	0.592242	12.72	15	9.910345	2.53	0. 10	13.63
16	.901264	2.58	.593005	12.73	16	.910497	2.55	. 28	13.67
17	.901419	2.58	.593769	12.73	17	.910650	2.53	. 48	13.67
18	.901574	2.58	.594533	12.77	18	.910802	2.55	. 68	13.70
19	.901729	2.58	.595299	12.78	19	.910955	2.53	. 90	13.72
20	9.901884	2.60	0.596066	12.78	20	9.911107	2.53	0. 13	13.72
21	.902040	2.58	.596833	12.80	21	.911259	2.55	. [illegible]	13.75
22	.902195	2.58	.597601	12.82	22	.911412	2.53	. 61	13.75
23	.902350	2.57	.598370	12.83	23	.911564	2.53	. 86	13.78
24	.902504	2.58	.599140	12.85	24	.911716	2.53	. 13	13.80
25	9.902659	2.58	0.599911	12.85	25	9.911868	2.53	0. 41	13.82
26	.902814	2.58	.600682	12.88	26	.912020	2.53	. 70	13.82
27	.902969	2.58	.601455	12.88	27	.912172	2.53	. 99	13.85
28	.903124	2.57	.602228	12.92	28	.912324	2.53	. 30	13.87
29	.903278	2.58	.603003	12.92	29	.912476	2.53	. 62	13.88
30	9.903433	2.58	0.603778	12.93	30	9.912628	2.53	0. 95	13.90
31	.903588	2.57	.604554	12.95	31	.912780	2.53	. 29	13.92
32	.903742	2.58	.605331	12.95	32	.912932	2.53	. 64	13.95
33	.903897	2.57	.606108	12.98	33	.913084	2.52	. 01	13.95
34	.904051	2.58	.606887	13.00	34	.913235	2.53	. 38	13.97
35	9.904206	2.57	0.607667	13.00	35	9.913387	2.53	0. 76	14.00
36	.904360	2.57	.608447	13.02	36	.913539	2.52	. 16	14.00
37	.904514	2.57	.609228	13.03	37	.913690	2.53	. 56	14.03
38	.904668	2.58	.610010	13.07	38	.913842	2.52	. 98	14.03
39	.904823	2.57	.610794	13.07	39	.913993	2.53	. 40	14.07
40	9.904977	2.57	0.611578	13.08	40	9.914145	2.52	0. 84	14 08
41	.905131	2.57	.612363	13.08	41	.914296	2.53	. 29	14.10
42	.905285	2.57	.613148	13.12	42	.914448	2.52	. 75	14.12
43	.905439	2.57	.613935	13.13	43	.914599	2.52	. 22	14.13
44	.905593	2 57	.614723	13.13	44	.914750	2.53	. 70	14.15
45	9.905747	2.57	0.615511	13.17	45	9.914902	2.52	0. 19	14 18
46	.905901	2.57	.616301	13.17	46	.915053	2.52	. 70	14.18
47	.906055	2.57	.617091	13.20	47	.915204	2.52	. 21	14.22
48	.906209	2.57	.617883	13.20	48	.915355	2.52	.667174	14.23
49	.906363	2.55	.618675	13.22	49	.915506	2.52	.668028	14.25
50	9. 16	2.57	0.619468	13.23	50	9.915657	2.52	0. 83	14.27
51	. 70	2.57	.620262	13.25	51	.915808	2.52	. 39	14.28
52	. 24	2.55	.621057	13.27	52	.915959	2.52	. 96	14.30
53	. 77	2.57	.621853	13.28	53	.916110	2.52	. 54	14.33
54	. 31	2.55	.622650	13.30	54	.916261	2.52	. 14	14.33
55	9. 84	2.57	0.623448	13.32	55	9.916412	2.50	0. 74	14.37
56	. 38	2.55	.624247	13.33	56	.916562	2.52	. 36	14.38
57	. 91	2.55	.625047	13.35	57	.916713	2.52	. 99	14.40
58	. 44	2.57	.625848	13.37	58	.916864	2.50	. 63	14.42
59	. 98	2.55	.626650	13.37	59	.917014	2.52	. 28	14.45
60	9. 51		0.627452		60	9.917165		0. 95	

80°				
M.	Vers.	D. 1″	Exsec.	D. 1″.
0	9.917165	2.52	0.677495	14.45
1	.917316	2.50	.678362	14.48
2	.917466	2.50	.679231	14.50
3	.917616	2.52	.680101	14.52
4	.917767	2.50	.680972	14.55
5	9.917917	2.52	0.681845	14.55
6	.918068	2.50	.682718	14.58
7	.918218	2.50	.683593	14.60
8	.918368	2.50	.684469	14.62
9	.918518	2.50	.685346	14.63
10	9.918668	2.50	0.686224	14.67
11	.918818	2.50	.687104	14.68
12	.918968	2.50	.687985	14.70
13	.919118	2.50	.688867	14.72
14	.919268	2.50	.689750	14.73
15	9.919418	2.50	0.690634	14.77
16	.919568	2.50	.691520	14.78
17	.919718	2.50	.692407	14.80
18	.919868	2.50	.693295	14.83
19	.920018	2.48	.694185	14.83
20	9.920167	2.50	0.[illegible]75	14.87
21	.920317	2.48	.[illegible]67	14.90
22	.920466	2.50	.[illegible]61	14.90
23	.920616	2.50	.[illegible]55	14.93
24	.920766	2.48	.[illegible]51	14.95
25	9.920915	2.48	0.[illegible]48	14.97
26	.921064	2.50	.[illegible]46	15.00
27	.921214	2.48	.[illegible]46	15.02
28	.921363	2.48	.[illegible]47	15.03
29	.921512	2.50	.[illegible]49	15.05
30	9.921662	2.48	0.704052	15.08
31	.921811	2.48	.704957	15.10
32	.921960	2.48	.705863	15.13
33	.922109	2.48	.706771	15.15
34	.922258	2.48	.707680	15.17
35	9.922407	2.48	0.708590	15.18
36	.922556	2.48	.709501	15.22
37	.922705	2.48	.710414	15.23
38	.922854	2.48	.711328	15.25
39	.923003	2.48	.712243	15.28
40	9.923152	2.48	0.713160	15.30
41	.923301	2 47	.714078	15.33
42	923449	2.48	.714998	15.35
43	.923598	2.48	.715919	15.37
44	923747	2.47	.716841	15.38
45	9.923895	2.48	0.717764	15.42
46	.924044	2.47	.718689	15.45
47	.924192	2.48	.719616	15.45
48	.924341	2.47	.720543	15.48
49	.924489	2.47	.721472	15.52
50	9.924637	2.48	0.722403	15.53
51	.924786	2.47	.723335	15.55
52	.924934	2.47	.724268	15.58
53	.925082	2.48	.725203	15 60
54	.925231	2.47	.726139	15.63
55	9.925379	2.47	0.727077	15.65
56	.925527	2.47	.728016	15.67
57	.925675	2.47	.728956	15.70
58	.925823	2.47	.729898	15.73
59	.925971	2.47	.730842	15.73
60	9.926119		0.731786	

0	9.926119	2.47	0.731786	15.78
1	.926267	2.47	.732733	15.78
2	.926415	2.45	.733680	15.83
3	.926562	2.47	.734630	15.83
4	.926710	2.47	.735580	15.87
5	9.926858	2.47	0.736532	15.90
6	.927006	2.45	.737486	15.92
7	.927153	2.47	738441	15.95
8	.927301	2.45	.739398	15.97
9	.927448	2.47	.740356	16.00
10	9.927596	2.45	0.741316	16.02
11	.[illegible]743	2.47	.742277	16.03
12	.[illegible]91	2.45	.743239	16.08
13	.[illegible]38	2.45	.744204	16.08
14	.[illegible]85	2.47	.745169	16.13
15	9.[illegible]33	2.45	0.746137	16.13
16	.[illegible]80	2.45	.747105	16.18
17	.[illegible]27	2.45	.748076	16.20
18	.[illegible]74	2.45	.749048	16.22
19	.[illegible]21	2.45	.750021	16.25
20	9.929068	2.45	0.750996	16.28
21	.929215	2.45	.751973	16.30
22	.929362	2.[illegible]	.752951	16.33
23	.929509	2.45	.753931	16.35
24	.929656	2.45	.754912	16.38
25	9.929803	2.45	0.755895	16.42
26	.929950	2.45	.756880	16.43
27	.930097	2.43	.757866	16.47
28	.930243	2.45	.758854	16.50
29	.930390	2.45	.759844	16.52
30	9.930537	2.43	0.760835	16.53
31	.930683	2 45	.761827	16.58
32	.930830	2.43	.762822	16.60
33	.930976	2.45	.763818	16.62
34	.931123	2.43	.764815	16.67
35	9.931269	2.45	0.765815	16.68
36	.931416	2.43	.766816	16.72
37	.931562	2.43	767819	16.73
38	.931708	2.45	.768823	16.77
39	.931855	2.43	.769829	16.80
40	9.932001	2.43	0.770837	16.82
41	.932147	2.43	.771846	16.87
42	.932293	2.43	.772858	16.87
43	.932439	2 43	.773870	16.92
44	.932585	2.43	774885	16.95
45	9.932731	2.43	0.775902	16.97
46	.932877	2.43	.776920	17.00
47	.933023	2.43	.777940	17.02
48	.933169	2.43	.778961	17.07
49	.933315	2.42	.779985	17.08
50	9.933460	2.43	0.[illegible]10	17.12
51	.933606	2.43	.[illegible]37	17.13
52	.933752	2.42	.[illegible]55	17.18
53	.933897	2.43	.[illegible]76	17 20
54	.934043	2.43	.[illegible]28	17.23
55	9.934189	2.42	0.[illegible]62	17 27
56	.934334	2.43	.[illegible]98	17.30
57	.934480	2.42	.[illegible]36	17.33
58	.934625	2.42	.[illegible]76	17.35
59	.934770	2.43	.790317	17.40
60	9.934916		0.791361	

0	9.934916	2.42	0.791361	17.42
1	.935061	2.42	.792406	17.45
2	.935206	2.43	.793453	17.48
3	.935352	2.42	.794502	17.50
4	.935497	2.42	.795552	17.55
5	9.935642	2.42	0.796605	17.58
6	.935787	2.42	.797660	17.60
7	.935932	2.42	.798716	17.63
8	.936077	2.42	.799774	17.68
9	.936222	2.42	.800835	17.70
10	9.936367	2.42	0.8 97	17.73
11	.936512	2.42	.8 61	17.77
12	.936657	2.40	.8 27	17.80
13	.936801	2.42	.8 95	17.83
14	.936946	2.42	.8 65	17.87
15	9.937091	2.42	0.8 37	17.90
16	.937236	2.40	.8 11	17.93
17	.937380	2.42	.8 87	17.97
18	.937525	2.40	.8 65	18.00
19	.937669	2.42	.8 45	18.03
20	9. 14	2.40	0.812627	18.07
21	. 58	2.42	.813711	18.10
22	. 03	2.40	.814797	18.13
23	. 47	2.40	.815885	18.17
24	. 91	2.42	.816975	18.20
25	9. 36	2.40	0.818067	18.23
26	. 80	2.40	.819161	18.27
27	. 24	2.40	.820257	18.32
28	. 68	2.40	.821356	18.33
29	.939112	2.42	.822456	18.38
30	9.939257	2.40	0.823559	18.42
31	.939401	2.40	.824664	18.43
32	.939545	2.38	. 70	18.48
33	.939688	2.40	. 79	18.52
34	.939832	2.40	. 90	18.57
35	9.939976	2.40	0. 04	18.58
36	.940120	2.40	. 19	18.63
37	.940264	2.40	. 37	18.65
38	.940408	2.38	. 56	18.70
39	.940551	2.40	. 78	18.75
40	9.940695	2.40	0. 03	18.77
41	.940839	2.38	. 29	18.80
42	.940982	2.40	. 57	18.85
43	.941126	2.38	. 88	18.88
44	.941269	2.40	. 21	18.93
45	9.941413	2.38	0. 57	18.95
46	.941556	2.38	. 94	19.00
47	.941699	2.40	. 34	19.03
48	.941843	2.38	. 76	19.08
49	.941986	2.38	.844921	19.12
50	9.942129	2.38	0.846068	19.15
51	.942272	2.38	.847217	19.18
52	.942415	2.40	.848368	19.23
53	.942559	2.38	.849522	19.27
54	.942702	2.38	.850678	19.30
55	9.942845	2.38	0.851836	19.35
56	.942988	2.38	.852997	19.40
57	.943131	2.37	.854161	19.42
58	.943273	2.38	.855326	19.47
59	.943416	2.38	.856494	19.52
60	9.943559		0.857665	

0	9.943559	2.38	0. 65	19.55
1	.943702	2.38	. 38	19.58
2	.943845	2.37	. 13	19.63
3	.943987	2.38	. 91	19.67
4	.944130	2.38	. 71	19.72
5	9.944273	2.37	0. 54	19.75
6	.944415	2.38	. 39	19.80
7	.944558	2.37	. 27	19.83
8	944700	2.38	. 17	19.88
9	.944843	2.37	. 10	19.92
10	9.944985	2.37	0.869505	19.97
11	.945127	2.38	.870703	20.00
12	.945270	2.37	.871903	20.05
13	.945412	2.37	.873106	20.10
14	.945554	2.37	.874312	20.13
15	9.945696	2.37	0.875520	20.18
16	.945838	2.38	.876731	20.23
17	.945981	2.37	.877945	20.27
18	.946123	2.37	.879161	20.30
19	.946265	2.37	.880379	20.37
20	9.946407	2.37	0.881601	20.40
21	.946549	2.35	.882825	20.45
22	.946690	2.37	.884052	20.48
23	.946832	2.37	.885281	20.55
24	.946974	2.37	886514	20.58
25	9.947116	2.37	0.887749	20.62
26	947258	2.35	.888986	20.68
27	.947399	2.37	.890227	20.72
28	.947541	2.37	.891470	20.77
29	.947683	2.35	.892716	20.82
30	9. 24	2.37	0.893965	20.87
31	. 66	2.35	.895217	20.92
32	. 07	2.37	.896472	20.95
33	. 49	2.35	.897729	21.00
34	. 90	2.35	.898989	21.07
35	9. 31	2.37	0.900253	21.10
36	. 73	2.35	.901519	21.15
37	. 14	2.35	.902788	21.20
38	. 55	2.35	.904060	21.25
39	. 96	2.35	.905335	21.30
40	9.949237	2.37	0.906613	21.33
41	.949379	2.35	.907893	21.40
42	.949520	2.35	.909177	21.45
43	.949661	2.35	.910464	21.50
44	.949802	2.35	.911754	21.55
45	9.949943	2.33	0.913047	21.60
46	.950083	2.35	.914343	21.65
47	.950224	2.35	.915642	21.70
48	.950365	2.35	.916944	21.75
49	.950506	2.35	.918249	21.82
50	9.950647	2.33	0.919558	21.85
51	.950787	2.35	.920869	21.92
52	.950928	2.35	.922184	21.97
53	.951069	2.33	.923502	22.02
54	.951209	2.35	924823	22.07
55	9.951350	2.33	0.926147	22.13
56	.951490	2.35	.927475	22.17
57	.951631	2.33	.928805	22.23
58	.951771	2.33	.930139	22.30
59	.951911	2.35	.931477	22.33
60	9.952052		0.932817	

84°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.952052	2.33	0.932817	22.40
1	.952192	2.33	.934161	22.45
2	.952332	2.35	.935508	22.52
3	.952473	2.33	.936859	22.57
4	.952613	2.33	.938213	22.62
5	9.952753	2.33	0.939570	22.68
6	.952893	2.33	.940931	22.75
7	.953033	2.33	.942296	22.78
8	.953173	2.33	.943663	22.85
9	.953313	2.33	.945034	22.92
10	9.953453	2.33	0.946409	22.97
11	.953593	2.32	.947787	23.03
12	.953732	2.33	.949169	23.08
13	.953872	2.33	.950554	23.15
14	.954012	2.33	.951943	23.22
15	9.954152	2.32	0.953336	23.27
16	.954291	2.33	.954732	23.33
17	.954431	2.33	.956132	23.38
18	.954571	2.32	.957535	23.45
19	.954710	2.33	.958942	23.52
20	9.954850	2.32	0.960353	23.57
21	.954989	2.33	.961767	23.65
22	.955129	2.32	.963186	23.70
23	.955268	2.32	.964608	23.77
24	.955407	2.33	.966034	23.82
25	9.955547	2.32	0.967463	23.90
26	.955686	2.32	.968897	23.95
27	.955825	2.32	.970334	24.02
28	.955964	2.32	.971775	24.10
29	.956103	2.33	.973221	24.15
30	9.956243	2.32	0.974670	24.22
31	.956382	2.32	.976123	24.28
32	.956521	2.32	.977580	24.35
33	.956660	2.32	.979041	24.42
34	.956799	2.30	.980506	24.48
35	9.956937	2.32	0.981975	24.55
36	.957076	2.32	.983448	24.63
37	.957215	2.32	.984926	24.68
38	.957354	2.32	.986407	24.77
39	.957493	2.30	.987893	24.83
40	9.957631	2.32	0.989383	24.90
41	.957770	2.32	.990877	24.97
42	.957909	2.30	.992375	25.03
43	.958047	2.32	.993877	25.12
44	.958186	2.30	.995384	25.18
45	9.958324	2.32	0.996895	25.27
46	.958463	2.30	.998411	25.33
47	.958601	2.30	.999931	25.40
48	.958739	2.32	1.001455	25.48
49	.958878	2.30	.002984	25.55
50	9.959016	2.30	1.004517	25.63
51	.959154	2.30	.006055	25.70
52	.959292	2.32	.007597	25.78
53	.959431	2.30	.009144	25.85
54	.959569	2.30	.010695	25.93
55	9.959707	2.30	1.012251	26.00
56	.959845	2.30	.013811	26.10
57	.959983	2.30	.015377	26.17
58	.960121	2.30	.016947	26.23
59	.960259	2.30	.018521	26.33
60	9.960397		1.020101	

85°				
M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.960397	2.30	1.020101	26.40
1	.960535	2.28	.021685	26.48
2	.960672	2.30	.023274	26.57
3	.960810	2.30	.024868	26.65
4	.960948	2.30	.026467	26.73
5	9.961086	2.28	1.028071	26.80
6	.961223	2.30	.029679	26.90
7	.961361	2.28	.031293	26.98
8	.961498	2.30	.032912	27.07
9	.961636	2.28	.034536	27.13
10	9.[illegible]73	2.30	1.036164	27.23
11	.[illegible]11	2.28	.037798	27.33
12	[illegible]48	2.30	.039438	27.40
13	.[illegible]86	2.28	.041082	27.50
14	.[illegible]23	2.28	.042732	27.58
15	9.[illegible]60	2.28	1.044387	27.67
16	.[illegible]97	2.30	.046047	27.77
17	.[illegible]35	2.28	.047713	27.85
18	.[illegible]72	2.28	.049384	27.93
19	.[illegible]09	2.28	.051060	28.03
20	9.963146	2.28	1.052742	28.13
21	.963283	2.28	.054430	28.22
22	.963420	2.28	.056123	28.30
23	.963557	2.28	.057821	28.40
24	.963694	2.28	.059525	28.50
25	9.963831	2.28	1.061235	28.60
26	.963968	2.27	.062951	28.68
27	.964104	2.28	.064672	28.78
28	.964241	2.28	.066399	28.88
29	.964378	2.28	.068132	28.98
30	9.964515	2.27	1.069871	29.08
31	.964651	2.28	.071616	29.18
32	.964788	2.27	.073367	29.28
33	.964924	2.28	.075124	29.38
34	.965061	2.27	.076887	29.48
35	9.965197	2.28	1.078656	29.58
36	.965334	2.27	.080431	29.68
37	.965470	2.28	.082212	29.80
38	.965607	2.27	.084000	29.90
39	.965743	2.27	.085794	30.00
40	9.[illegible]79	2.28	1.087594	30.12
41	.[illegible]16	2.27	.089401	30.22
42	.[illegible]52	2.27	.091214	30.32
43	.[illegible]88	2.27	.093033	30.43
44	.[illegible]24	2.27	.094859	30.55
45	9.[illegible]60	2.27	1.096692	30.67
46	.[illegible]96	2.27	.098532	30.77
47	.[illegible]32	2.27	.100378	30.87
48	.[illegible]68	2.27	.102230	31.00
49	.967104	2.27	.104090	31.12
50	9.967240	2.27	1.105957	31.22
51	.967376	2.27	.107830	31.35
52	.967512	2.25	.109711	31.45
53	.967647	2.27	.111598	31.58
54	.967783	2.27	.113493	31.68
55	9.967919	2.25	1.115394	31.82
56	.968054	2.27	.117303	31.93
57	.968190	2.27	.119219	32.07
58	.968326	2.25	.121143	32.18
59	.968461	2.27	.123074	32.30
60	9.968597		1.125012	

				″.
0	9.968597	2.25	1.125013	32.43
1	.968732	2.27	.126958	32.55
2	.968868	2.25	.128911	32.70
3	.969003	2.25	.130873	32.80
4	.969138	2.27	.132841	32.95
5	9.969274	2.25	1.134818	33.07
6	.969409	2.25	.136802	33.21
7	.969544	2.25	.138795	33.33
8	.969679	2.25	.140795	33.47
9	.969814	2.25	.142803	33.62
10	9.969949	2.25	1.144820	33.73
11	.970084	2.25	.146844	33.88
12	.970219	2.25	.148877	34.02
13	.970354	2.25	.150918	34.17
14	.970489	2.25	.152968	34.30
15	9.970624	2.25	1.155026	34.43
16	.970759	2.25	.157092	34.60
17	.970894	2.25	.159168	34.73
18	.971029	2.25	.161252	34.87
19	.971164	2.23	.163344	35.03
20	9.971298	2.25	1.165446	35.17
21	.971433	2.25	.167556	35.33
22	.971568	2.23	.169676	35.48
23	.971702	2.25	.171805	35.63
24	.971837	2.23	.173943	35.78
25	9.971971	2.25	1.176090	35.93
26	.972106	2.23	.178246	36.10
27	.972240	2.23	.180412	36.27
28	.972374	2.25	.182588	36.42
29	.972509	2.23	.184773	36.58
30	9.972643	2.23	1.186968	36.75
31	.972777	2.25	.189173	36.90
32	.972912	2.23	.191387	37.08
33	.973046	2.23	.193612	37.25
34	.973180	2.23	.195847	37.42
35	9.973314	2.23	1.198092	37.58
36	.973448	2.23	.200347	37.77
37	.973582	2.23	.202613	37.93
38	.973716	2.23	.204889	38.12
39	.973850	2.23	.207176	38.28
40	9.973984	2.23	1.209473	38.47
41	.974118	2.23	.211781	38.67
42	.974252	2.23	.214101	38.83
43	.974386	2.22	.216431	39.03
44	.974519	2.23	.218773	39.20
45	9.974653	2.23	1.221125	39.42
46	.974787	2.22	.223490	39.58
47	.974920	2.23	.225865	39.80
48	.975054	2.23	.228253	39.98
49	.975188	2.22	.230652	40.18
50	9.975321	2.23	1.233063	40.38
51	.975455	2.22	.235486	40.58
52	.975588	2.23	.237921	40.78
53	.975722	2.22	.240368	41.00
54	.975855	2.22	.242828	41.20
55	9.975988	2.23	1.245300	41.42
56	.976122	2.22	.247785	41.63
57	.976255	2.22	.250283	41.83
58	.976388	2.22	.252793	42.07
59	.976521	2.22	.255317	42.28
60	9.976654		1.257854	

87°

M.	Vers.	D. 1″.	Exsec.	D. 1″.
0	9.976654	2.23	1.257854	42.52
1	.976788	2.22	.260405	42.73
2	.976921	2.22	.262969	42.95
3	.977054	2.22	.265546	43.20
4	.977187	2.22	.268138	43.42
5	9.977320	2.20	1.270743	43.67
6	.977452	2.22	.273363	43.88
7	.977585	2.22	.275996	44.15
8	.977718	2.22	.278645	44.38
9	.977851	2.22	.281308	44.63
10	9.977984	2.20	1.283986	44.88
11	.978116	2.22	.286679	45.13
12	.978249	2.22	.289387	45.38
13	.978382	2.20	.292110	45.65
14	.978514	2.22	.294849	45.92
15	9.978647	2.20	1.297604	46.17
16	.978779	2.22	.300374	46.45
17	.978912	2.20	.303161	46.72
18	.979044	2.22	.305964	47.00
19	.979177	2.20	.308784	47.27
20	9.979309	2.22	1.311620	47.55
21	.979442	2.20	.314473	47.83
22	.979574	2.20	.317343	48.13
23	.979706	2.20	.320231	48.43
24	.979838	2.20	.323137	48.72
25	9.979970	2.22	1.326060	49.02
26	.980103	2.20	.329001	49.33
27	.980235	2.20	.331961	49.63
28	.980367	2.20	.334939	49.93
29	.980499	2.20	.337935	50.27
30	9.980631	2.20	1.340951	50.58
31	.980763	2.20	.343986	50.92
32	.980895	2.18	.347041	51.23
33	.981026	2.20	.350115	51.58
34	.981158	2.20	.353210	51.92
35	9.981290	2.20	1.356325	52.25
36	.981422	2.20	.359460	52.62
37	.981554	2.18	.362617	52.95
38	.981685	2.20	.365794	53.32
39	.981817	2.20	.368993	53.68
40	9.981949	2.18	1.372214	54.07
41	.982080	2.20	.375458	54.42
42	.982212	2.18	.378723	54.80
43	.982343	2.20	.382011	55.20
44	.982475	2.18	.385323	55.58
45	9.982606	2.18	1.388658	55.97
46	.982737	2.20	.392016	56.38
47	.982869	2.18	.395399	56.80
48	.983000	2.18	.398807	57.20
49	.983131	2.18	.402239	57.62
50	9.983262	2.20	1.405696	58.07
51	.983394	2.18	.409180	58.48
52	.983525	2.18	.412689	58.93
53	.983656	2.18	.416225	59.38
54	.983787	2.18	.419788	59.83
55	9.983918	2.18	1.423378	60.28
56	.984049	2.18	.426995	60.77
57	.984180	2.18	.430641	61.25
58	.984311	2.18	.434316	61.73
59	.984442	2.18	.438020	62.22
60	9.984573		1.441753	

0	9.984573	2.17	1.441753	62.73	0	9.992354	2.13	1.750498	
1	.984703	2.18	.445517	63.23	1	.992482	2.15	.757925	
2	.984834	2.18	.449311	63.77	2	.992611	2.13	.765477	
3	.984965	2.18	.453137	64.28	3	.992739	2.15	.773158	
4	.985096	2.17	.456994	64.82	4	.992868	2.13	.780973	
5	9.985226	2.18	1.460883	65.37	5	9.992996	2.13	1.788926	
6	.985357	2.17	.464805	65.93	6	.993124	2.15	.797022	
7	.985487	2.18	.468761	66.50	7	.993253	2.13	.805268	
8	.985618	2.17	.472751	67.07	8	.993381	2.13	.813668	
9	.985748	2.18	.476775	67.65	9	.993509	2.13	.822229	
10	9.985879	2.17	1.480834	68.25	10	9.993637	2.13	1.830996	
11	.986009	2.18	.484929	68.87	11	.993765	2.15	.839858	
12	.986140	2.17	.489061	69.48	12	.993894	2.13	.848940	
13	.986270	2.17	.493230	70.12	13	.994022	2.13	.858211	
14	.986400	2.18	.497437	70.77	14	.994150	2.13	.867679	
15	9.986531	2.17	1.501683	71.42	15	9.994278	2.13	1.877351	
16	.986661	2.17	.505968	72.08	16	.994406	2.13	.887239	
17	.986791	2.17	.510293	72.77	17	.994534	2.13	.897350	
18	.986921	2.17	.514659	73.45	18	.994662	2.12	.907697	
19	.987051	2.17	.519066	74.17	19	.994789	2.13	.918290	
20	9. 81	2.17	1.523516	74.90	20	9.994917	2.13	1. 41	
21	. 11	2.17	.528010	75.63	21	.995045	2.13	. 64	
22	. 41	2.17	.532548	76.38	22	.995173	2.13	. 72	
23	. 71	2.17	.537131	77.15	23	.995301	2.12	. 81	
24	. 01	2.17	.541760	77.95	24	.995428	2.13	. 08	
25	9. 31	2.17	1.546437	78.73	25	9.995556	2.12	1. 69	
26	. 61	2.17	.551161	79.57	26	.995683	2.13	2. 85	
27	. 91	2.17	.555935	80.40	27	.995811	2.13	. 78	
28	. 21	2.15	.560759	81.25	28	.995939	2.12	. 69	
29	. 50	2.17	.565634	82.12	29	.996066	2.12	. 84	
30	9. 80	2.17	1.570561	83.02	30	9.996193	2.13	2.055352	
31	. 10	2.15	.575542	83.93	31	.996321	2.12	.070203	
32	. 39	2.17	.580578	84.87	32	.996448	2.13	.085569	
33	. 69	2.15	.585670	85.82	33	.996576	2.12	.101490	
34	. 98	2.17	.590819	86.80	34	.996703	2.12	.118008	
35	9. 28	2.15	1.596027	87.80	35	9.996830	2.12	2.135168	
36	. 57	2.17	.601295	88.83	36	.996957	2.13	.153024	
37	. 87	2.15	.606625	89.88	37	.997085	2.12	.171634	
38	. 16	2.17	.612018	90.95	38	.997212	2.12	.191066	
39	. 46	2.15	.617475	92.05	39	.997339	2.12	.211396	
40	9.989775	2.15	1. 98	93.18	40	9.997466	2.12	2.232712	
41	.989904	2.17	. 89	94.35	41	.997593	2.12	.255116	
42	.990034	2.15	. 50	95.53	42	.997720	2.12	.278723	
43	.990163	2.15	. 82	96.77	43	.997847	2.12	.303674	
44	.990292	2.15	. 88	98.00	44	.997974	2.12	.330129	
45	9.990421	2.15	1. 68	99.30	45	9.998101	2.12	2.358285	
46	.990550	2.15	. 26	100.62	46	.998228	2.12	.388375	
47	.990679	2.15	. 63	101.97	47	.998355	2.10	.420686	
48	.990808	2.15	. 81	103.38	48	.998481	2.12	.455575	
49	.990937	2.15	. 84	104.80	49	.998608	2.12	.493490	
50	9.991066	2.15	1.682272	106.28	50	9.998735	2.12	2.535009	
51	.991195	2.15	.688649	107.80	51	.998862	2.10	.580893	
52	.991324	2.15	.695117	109.37	52	998988	2.12	.632172	
53	.991453	2.15	.701679	110.98	53	.999115	2.10	.690291	
54	.991582	2.13	.708338	112.65	54	.999241	2.12	.757364	
55	9.991710	2.15	1.715097	114.35	55	9.999368	2.10	2.836672	
56	.991839	2.15	.721958	116.12	56	.999494	2.12	.933708	
57	.991968	2.13	.728925	117.95	57	.999621	2.10	3.058774	
58	.992096	2.15	.736002	119.83	58	.999747	2.12	.234991	2930. 55
59	.992225	2.15	.743192	121.77	59	.999874	2.10	.536148	9019. 22
60	9.992354		1.750498		60	0.000000		∞	

	0°			1°			2°			
M	S.	Vers.	Exsec.	S.	Vers.	Exsec.	S.	Vers.	Exsec.	M.
		9.07			9.07			9.07		
0	0	0120	0120	3600	0109	0175	7200	0076	0340	0
1	60	0120	0120	3660	0108	0177	7260	0075	0344	1
2	120	0120	0120	3720	0108	0179	7320	0074	0348	2
3	180	0120	0120	3780	0108	0181	7380	0073	0351	3
4	240	0120	0120	3840	0107	0182	7440	0073	0355	4
5	300	0120	0120	3900	0107	0184	7500	0072	0359	5
6	360	0120	0120	3960	0106	0186	7560	0071	0363	6
7	420	0120	0120	4020	0106	0188	7620	0070	0367	7
8	480	0120	0121	4080	0106	0191	7680	0070	0371	8
9	540	0119	0121	4140	0105	0193	7740	0069	0375	9
10	600	0119	0121	4200	0105	0195	7800	0068	0379	10
11	660	0119	0122	4260	0104	0197	7860	0067	0383	11
12	720	0119	0122	4320	0104	0199	7920	0066	0387	12
13	780	0119	0122	4380	0103	0201	7980	0066	0391	13
14	840	0119	0123	4440	0103	0204	8040	0065	0395	14
15	900	0119	0123	4500	0103	0206	8100	0064	0399	15
16	960	0119	0124	4560	0102	0208	8160	0063	0403	16
17	1020	0119	0124	4620	0102	0211	8220	0062	0407	17
18	1080	0119	0125	4680	0101	0213	8280	0061	0411	18
19	1140	0119	0125	4740	0101	0215	8340	0061	0416	19
20	1200	0119	0126	4800	0100	0218	8400	0060	0420	20
21	1260	0118	0126	4860	0100	0220	8460	0059	0424	21
22	1320	0118	0127	4920	0099	0223	8520	0058	0429	22
23	1380	0118	0128	4980	0099	0225	8580	0057	0433	23
24	1440	0118	0129	5040	0098	0228	8640	0056	0437	24
25	1500	0118	0129	5100	0098	0230	8700	0055	0442	25
26	1560	0118	0130	5160	0097	0233	8760	0054	0446	26
27	1620	0118	0131	5220	0097	0236	8820	0054	0451	27
28	1680	0117	0132	5280	0096	0238	8880	0053	0455	28
29	1740	0117	0133	5340	0095	0241	8940	0052	0460	29
30	1800	0117	0134	5400	0095	0244	9000	0051	0464	30
31	1860	0117	0134	5460	0094	0247	9060	0050	0469	31
32	1920	0117	0135	5520	0094	0249	9120	0049	0474	32
33	1980	0116	0136	5580	0093	0252	9180	0048	0478	33
34	2040	0116	0137	5640	0093	0255	9240	0047	0483	34
35	2100	0116	0138	5700	0092	0258	9300	0046	0488	35
36	2160	0116	0140	5760	0092	0261	9360	0045	0493	36
37	2220	0116	0141	5820	0091	0264	9420	0044	0497	37
38	2280	0115	0142	5880	0090	0267	9480	0043	0502	38
39	2340	0115	0143	5940	0090	0270	9540	0042	0507	39
40	2400	0115	0144	6000	0089	0273	9600	0041	0512	40
41	2460	0115	0145	6060	0088	0276	9660	0040	0517	41
42	2520	0114	0147	6120	0088	0279	9720	0039	0522	42
43	2580	0114	0148	6180	0087	0282	9780	0038	0527	43
44	2640	0114	0149	6240	0087	0285	9840	0037	0532	44
45	2700	0114	0151	6300	0086	0289	9900	0036	0537	45
46	2760	0113	0152	6360	0085	0292	9960	0035	0542	46
47	2820	0113	0154	6420	0085	0295	10020	0034	0547	47
48	2880	0113	0155	6480	0084	0298	10080	0033	0552	48
49	2940	0112	0157	6540	0083	0302	10140	0032	0557	49
50	3000	0112	0158	6600	0083	0305	10200	0031	0562	50
51	3060	0112	0160	6660	0082	0308	10260	0030	0568	51
52	3120	0111	0161	6720	0081	0312	10320	0029	0573	52
53	3180	0111	0163	6780	0081	0315	10380	0028	0578	53
54	3240	0111	0164	6840	0080	0319	10440	0027	0584	54
55	3300	0110	0166	6900	0079	0322	10500	0026	0589	55
56	3360	0110	0168	6960	0079	0326	10560	0025	0594	56
57	3420	0110	0169	7020	0078	0329	10620	0024	0600	57
58	3480	0109	0171	7080	0077	0333	10680	0023	0605	58
59	3540	0109	0173	7140	0076	0337	10740	0022	0611	59
M						ec.				

	5°			
Exsec.	S.	Vers.	Exsec.	M.
9.07		9.06	9.07	
1003	18000	9844	1500	0
1010	18060	9842	1509	1
1017	18120	9840	1518	2
1025	18180	9839	1528	3
1032	18240	9837	1537	4
1040	18300	9835	1546	5
1047	18360	9833	1556	6
1055	18420	9831	1565	7
1062	18480	9829	1575	8
1070	18540	9827	1585	9
1078	18600	9825	1594	10
1085	18660	9824	1603	11
1093	18720	9822	1613	12
1101	18780	9820	1622	13
1109	18840	9818	1632	14
1116	18900	9816	1642	15
1124	18960	9814	1651	16
1132	19020	9812	1661	17
1140	19080	9810	1671	18
1148	19140	9808	1681	[illegible]
1156	19200	9806	1690	20
1164	19260	9804	1700	21
1172	19320	9802	1710	22
1180	19380	9800	1720	23
1188	19440	9798	1730	24
1196	19500	9796	1740	[illegible]
1204	19560	9794	1750	[illegible]
1213	19620	9792	1760	27
1221	19680	9790	1770	28
1229	19740	9788	1780	29
1237	19800	9786	1790	30
1246	19860	9784	1800	31
1254	19920	9782	1811	32
1202	19980	9780	1821	33
1271	20040	9778	1831	34
1279	20100	9776	1841	35
1288	20160	9774	1852	36
1296	20220	9772	1862	37
1305	20280	9770	1872	38
1313	20340	9768	1883	39
1322	20400	9766	1893	40
1330	20460	9764	1904	41
1339	20520	9762	1914	42
1348	20580	9759	1925	43
1356	20640	9757	1935	44
1365	20700	9755	1946	45
1374	20760	9753	1956	46
1383	20820	9751	1967	47
1392	20880	9749	1978	48
1400	20940	9747	1988	49
1409	21000	9745	1999	50
1418	21060	9742	2010	51
1427	21120	9740	2021	52
1436	21180	9738	2032	53
1445	21240	9736	2043	54
1454	21300	9734	2053	55
1463	21360	9732	2064	56
1472	21420	9729	2075	57
1482	21480	9727	2086	58
1491	21540	9725	2097	60

TABLE XVII.—NATURAL SINES AND COSINES.

M.	0° Sin.	Cos.	1° Sin.	Cos.	2° Sin.	Cos.	3° Sin.	C			
0	.00000	1.0000	01745	.99985	.03490	.99939	.05234	.99863	.06976	.99756	60
1	029	000	774	984	519	938	263	861	.07005	754	59
2	058	000	803	984	548	937	292	860	034	752	58
3	087	000	832	983	577	936	321	858	063	750	57
4	116	000	862	983	606	935	350	857	092	748	56
5	.00145	1.0000	.01891	.99982	.03635	.99934	.05379	.99855	.07121	.99746	55
6	175	000	920	982	664	933	408	854	150	744	54
7	204	000	949	981	693	932	437	852	179	742	53
8	233	000	978	980	723	931	466	851	208	740	52
9	262	000	.02007	980	752	930	495	849	237	738	51
10	.00291	1.0000	.02036	.99979	.03781	.99929	05524	.99847	.07266	.99736	50
11	320	.99999	065	979	810	927	553	846	295	734	49
12	349	999	094	978	839	926	582	844	324	731	48
13	378	999	123	977	868	925	611	842	353	729	47
14	407	999	152	977	897	924	640	841	382	727	46
15	.00436	.99999	.02181	.99976	.03926	.99923	.05669	.99839	07411	.99725	45
16	465	999	211	976	955	922	698	838	440	723	44
17	495	999	240	975	984	921	727	836	469	721	43
18	524	999	269	974	.04013	919	756	834	498	719	42
19	553	998	298	974	042	918	785	833	527	716	41
20	.00582	.99998	.02327	.99973	.04071	.99017	.05814	.99831	.07556	.99714	40
21	611	998	356	972	100	6	844	829	585	712	39
22	640	998	385	972	129	5	873	827	614	710	38
23	669	998	414	971	159	3	902	826	643	708	37
24	698	998	443	970	188	2	931	824	672	705	36
25	.00727	.99997	.02472	.99969	.04217	.99 1	.05960	.99822	.07701	.99703	35
26	756	997	501	969	246	0	989	821	730	701	34
27	785	997	530	968	275	9	.06018	819	759	699	33
28	814	997	560	967	304	7	047	817	788	696	32
29	844	996	589	966	333	6	076	815	817	694	31
30	.00873	.99996	.02618	.99966	.04362	.99 5	.06105	.99813	.07846	.99692	30
31	902	996	647	965	391	4	134	812	875	689	29
32	931	996	676	964	420	2	163	810	904	687	28
33	960	995	705	963	449	1	192	808	933	685	27
34	989	995	734	963	478	0	221	806	962	683	26
35	.01018	99995	.02763	.99962	.04507	.99 8	.06250	.99804	.07991	.99680	25
36	047	995	792	961	536	7	279	803	.08020	678	24
37	076	994	821	960	565	6	308	801	049	676	23
38	105	994	850	959	594	4	337	799	078	673	22
39	134	[illegible]	879	959	623	3	366	797	107	671	21
40	.01164	.99993	.02908	.99958	.04653	.99 2	.06395	.99795	.08136	.99668	20
41	193	993	938	957	682	0	424	793	165	666	19
42	222	993	967	956	711	9	453	792	194	664	18
43	251	992	996	955	740	5	482	790	223	661	17
44	280	992	.03025	954	769	5	511	788	252	659	16
45	.01309	99991	.03054	.99953	.04798	.99 5	.06540	.99786	.08281	.99657	15
46	338	991	083	952	827	3	569	784	310	654	14
47	367	991	112	952	856	2	598	782	339	652	13
48	396	990	141	951	885	1	627	780	368	649	12
[illegible]	425	990	170	950	914	879	656	778	397	647	11
50	.01454	.99989	.03199	.99949	.04943	.99878	.06685	.99776	.08426	99644	10
51	483	989	228	948	972	876	714	774	455	642	9
52	513	989	257	947	.05001	875	743	772	484	639	8
53	542	988	286	946	030	873	773	770	513	637	7
54	571	988	316	945	059	872	802	768	542	635	6
55	.01600	.99987	.03345	.99944	.05088	.99870	.06831	.99766	.08571	.99632	5
56	629	987	374	943	117	869	860	764	600	630	4
57	658	986	403	942	146	867	889	762	629	627	3
58	687	986	432	941	175	866	918	760	658	625	2
59	716	985	461	940	205	864	947	758	687	622	1
60	.01745	.99985	.03490	.99939	.05234	.99863	.06976	.99756	.08716	.99619	0
		.	Co							.	M.

	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	
0	.08716	.99619	.10453	.99452	.12187	.99255	.13917	.99027	.15643	.98769	[illegible]
1	745	617	482	449	216	251	946	023	672	764	59
2	774	614	511	446	245	248	975	019	701	760	58
3	803	612	[illegible]	443	274	244	.14004	015	730	755	57
4	831	609	569	440	302	240	033	011	758	751	56
5	.08860	.99607	.10597	99437	.12331	.99237	.14061	.99006	.15787	.98746	55
6	889	604	626	434	360	233	090	002	816	741	54
7	918	602	655	431	389	230	119	.98998	845	737	53
8	947	599	684	428	418	226	148	994	873	732	52
9	976	596	713	424	447	222	177	990	902	728	51
10	.09005	.99594	.10742	.99421	.12476	.99219	.14205	.98986	.15931	.98723	50
11	034	591	771	418	504	215	234	982	959	718	49
12	063	588	800	415	533	211	263	978	988	714	48
13	092	586	829	412	562	208	292	973	.16017	709	47
14	121	583	858	409	591	204	320	969	046	704	46
15	.09150	.99580	.10887	.99406	.12620	.99200	.14349	.98965	.16074	.98700	45
16	179	578	916	402	649	197	378	961	103	695	44
17	208	575	945	399	678	193	407	957	132	690	43
18	237	572	973	396	706	189	436	953	160	686	42
19	266	570	.11002	393	735	186	464	948	189	681	41
20	.09295	.99567	.11031	.99390	.12764	.99182	.14493	.98944	.16218	.98676	40
21	324	564	060	386	793	178	522	940	246	671	39
22	353	562	089	383	822	175	551	936	275	667	38
23	382	559	118	380	851	171	580	931	304	662	37
24	411	556	147	377	880	167	608	927	333	657	36
25	09440	.99553	.11176	.99374	.12908	.99163	.14637	.98923	.16361	.98652	35
26	469	551	205	370	937	160	666	919	390	648	34
27	498	548	234	367	966	156	695	914	419	643	33
28	527	545	263	364	995	152	723	910	447	638	32
29	556	542	291	360	.13024	148	752	906	476	633	31
30	.09585	.99540	.11320	.99357	.13053	.99144	.14781	.98902	.16505	.98629	30
31	614	537	349	354	081	141	810	897	533	624	29
32	642	534	378	351	110	137	838	893	562	619	28
33	671	531	407	347	139	133	867	889	591	614	27
34	700	528	436	344	168	129	896	[illegible]	620	609	26
35	.09729	.99526	.11465	99341	.13197	.99125	.14925	.98880	.16648	.98604	25
36	758	523	494	337	226	122	954	876	677	600	24
37	787	520	523	334	254	118	982	871	706	595	23
38	816	517	552	331	283	114	.15011	867	734	590	22
39	845	514	580	327	312	110	040	863	763	585	21
40	.09874	.99511	.11609	.99324	.13341	.99106	.15069	.98858	.16792	.98580	20
41	903	508	638	320	370	102	097	854	820	575	19
42	932	506	667	317	399	098	126	849	849	570	18
43	961	503	696	314	427	094	155	845	878	565	17
44	990	500	725	310	456	091	184	841	906	561	16
45	10019	.99497	.11754	.99307	.13485	.99087	.15212	.98836	.16935	.98556	15
46	048	494	783	303	514	083	241	832	964	551	14
47	077	491	812	300	543	079	270	827	992	546	13
48	106	488	840	297	572	075	299	823	.17021	541	12
49	135	485	869	293	600	071	327	818	050	536	11
50	.10164	.99482	.11898	.99290	.13629	.99067	.15356	.98814	.17078	.98531	10
51	192	479	927	286	658	063	385	809	107	526	9
52	221	476	956	283	687	059	414	805	136	521	8
53	250	473	985	279	716	055	442	800	164	516	7
54	279	470	.12014	276	744	051	471	796	193	511	6
55	.10308	.99467	12043	.99272	.13773	.99047	.15500	.98791	.17222	.98506	5
56	337	464	071	269	802	043	529	787	250	501	4
57	366	461	100	265	831	039	557	782	279	496	3
58	395	458	129	262	860	035	586	778	308	491	2
59	424	455	158	258	889	031	615	773	336	486	1
60	.10453	.99452	.12187	.99255	.13917	.99027	.15643	98769	.17365	.98481	0
	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin	
	84°		83°		82°		81°		80°		M

[illegible]	10°		11°		12°		13°		14°		
	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	[illegible]	Cos.	Sin.	Cos.	
0	.17365	.98481	.19081	.98163	.20791	97815	.22495	[illegible]	.24192	.97030	60
1	393	[illegible]	109	157	820	809	523	[illegible]	220	023	59
2	422	[illegible]	138	152	848	803	552	[illegible]	249	015	58
3	451	[illegible]	167	146	877	797	580	[illegible]	277	008	57
4	479	[illegible]	195	140	905	791	608	[illegible]	305	001	56
[illegible]	.17508	[illegible]	.19224	98135	.20933	.97784	.22637	[illegible]	.24333	.96994	55
[illegible]	537	[illegible]	252	129	962	778	665	[illegible]	362	987	54
7	565	[illegible]	281	124	990	772	693	[illegible]	390	980	53
8	594	[illegible]	309	118	.21019	766	722	[illegible]	418	973	52
[illegible]	623	[illegible]	338	112	047	760	750	[illegible]	446	966	51
10	.17651	[illegible]	.19366	.98107	.21076	.97754	.22778	.97371	.24474	.96959	50
11	680	[illegible]	395	101	104	748	807	365	503	952	49
12	708	[illegible]	423	096	132	742	835	358	531	945	48
13	737	[illegible]	452	090	161	735	863	351	559	937	47
14	766	[illegible]	481	084	189	729	892	345	587	930	46
15	.17794	[illegible]	.19509	.98079	.21218	.97723	.22920	.97338	.24615	.96923	45
16	823	[illegible]	538	073	246	717	948	331	644	916	44
17	852	[illegible]	566	067	275	711	977	325	672	909	43
18	880	[illegible]	595	061	303	705	.23005	318	700	902	42
19	909	[illegible]	623	056	331	698	033	311	728	894	41
20	.17937	[illegible]	.19652	.98050	.21360	.97692	.23062	.97304	.24756	.96887	40
21	966	[illegible]	680	044	388	686	090	298	784	880	39
22	995	[illegible]	709	039	417	680	118	291	813	873	38
23	.18023	[illegible]	737	033	445	673	146	284	841	866	37
24	052	[illegible]	766	027	474	667	175	278	869	858	36
25	.18081	[illegible]	.19794	.98021	.21503	.97661	.23203	.97271	.24897	.96851	35
26	109	[illegible]	823	016	530	655	231	264	925	844	34
27	138	[illegible]	851	010	559	648	260	257	954	837	33
28	166	[illegible]	880	004	587	642	288	251	982	829	32
29	195	[illegible]	908	.97998	616	636	316	244	.25010	822	31
30	.18224	[illegible]	.19937	.97992	.21644	.97630	.23345	.97237	.25038	.96815	30
31	252	[illegible]	965	987	672	623	373	230	066	807	29
32	281	[illegible]	994	981	701	617	401	223	094	800	28
33	309	[illegible]	.20022	975	729	611	429	217	122	793	27
34	338	[illegible]	051	969	758	604	458	210	151	786	26
35	.18367	[illegible]	.20079	.97963	.21786	.97598	.23486	.97203	.25179	.96778	25
36	395	[illegible]	108	958	814	592	514	196	207	771	24
37	424	[illegible]	136	952	843	585	542	189	235	764	23
38	452	[illegible]	165	946	871	579	571	182	263	756	22
39	481	[illegible]	193	940	899	573	599	176	291	749	21
40	.18509	[illegible]	.20222	.97934	.21928	.97566	.23627	.97169	.25320	.96742	20
41	538	[illegible]	250	928	956	560	656	162	348	734	19
42	567	[illegible]	279	922	985	553	684	155	376	727	18
43	595	[illegible]	307	916	.22013	547	712	148	404	719	17
44	624	[illegible]	336	910	041	541	740	141	432	712	16
45	.18652	[illegible]	.20364	.97905	.22070	.97534	.23769	.97134	.25460	.96705	15
46	681	[illegible]	393	899	098	528	797	127	488	697	14
47	710	[illegible]	421	893	126	521	825	120	516	690	13
48	738	[illegible]	450	887	155	515	853	113	545	682	12
49	767	[illegible]	478	881	183	508	882	106	573	675	11
50	.18795	[illegible]	.20507	.97875	.22212	.97502	.23910	.97100	.25601	.96667	10
51	824	[illegible]	535	869	240	496	938	093	629	660	9
52	852	[illegible]	563	863	268	489	966	086	657	653	8
53	881	[illegible]	592	857	297	483	995	079	685	645	7
54	910	196	620	851	325	476	24023	072	713	638	6
55	18938	.98190	.20649	.97845	.22353	.97470	.24051	.97065	25741	.96630	5
56	967	185	677	839	382	463	079	058	769	623	4
57	995	179	706	833	410	457	108	051	798	615	3
58	.19024	174	734	827	438	450	136	044	826	608	2
59	052	168	763	821	467	444	164	037	854	600	1
60	.19081	98163	.20791	97815	22405	.97437	.24192	.97030	.25882	.96593	0
										Sin. °	M.

M.	15° Sin.	15° Cos.	16° Sin.	16° Cos.	17° Sin.	17° Cos.	18° Sin.	18° Cos.	19° Sin.	19° Cos.	
0	.25882	.96593	.27564	.96126	.29237	.95630	.30902	.95106	.32557	.94552	60
1	910	585	592	118	265	622	929	097	584	542	59
2	938	578	620	110	293	613	957	088	612	533	58
3	966	570	648	102	321	605	985	079	639	523	57
4	994	562	676	094	348	596	.31012	070	667	514	56
5	.26022	.96555	.27704	.96086	.29376	.95588	.31040	.95061	.32694	.94504	55
6	050	547	731	078	404	579	068	052	722	495	54
7	079	540	759	070	432	571	095	043	749	485	53
8	107	532	787	062	460	562	123	033	777	476	52
9	135	524	815	054	487	554	151	024	804	466	51
10	.26163	.96517	.27843	.96046	.29515	.95545	.31178	.95015	.32832	.94457	50
11	191	509	871	037	543	536	206	006	859	447	49
12	219	502	899	029	571	528	233	.94997	887	438	48
13	247	494	927	021	599	519	261	988	914	428	47
14	275	486	955	013	626	511	289	979	942	418	46
15	.26303	.96479	.27983	.96005	.29654	.95502	.31316	.94970	.32969	.94409	45
16	331	471	.28011	.95997	682	493	344	961	997	399	44
17	359	463	039	989	710	485	372	952	.33024	390	43
18	387	456	067	981	737	476	399	943	051	380	42
19	415	448	095	972	765	467	427	933	079	370	41
20	.26443	.96440	.28123	.95964	.29793	.95459	.31454	.94924	.33106	.94361	40
21	471	433	150	956	821	450	482	915	134	351	39
22	500	425	178	948	849	441	510	906	161	342	38
23	528	417	206	940	876	433	537	897	189	332	37
24	556	410	234	931	904	424	565	888	216	322	36
25	.26584	.96402	.28262	.95923	.29932	.95415	.31593	.94878	.33244	.94313	35
26	612	394	290	915	960	407	620	869	271	303	34
27	640	386	318	907	987	398	648	860	298	293	33
28	668	379	346	898	.30015	389	675	851	326	284	32
29	696	371	374	890	043	380	703	842	353	274	31
30	.26724	.96363	.28402	.95882	.30071	.95372	.31730	.94832	.33381	.94264	30
31	752	355	429	874	098	363	758	823	408	254	29
32	780	347	457	865	126	354	786	814	436	245	28
33	808	340	485	857	154	345	813	805	463	235	27
34	836	332	513	849	182	337	841	795	490	225	26
35	.26864	.96324	.28541	.95841	.30209	.95328	.31868	.94786	.33518	.94215	25
36	892	316	569	832	237	319	896	777	545	206	24
37	920	308	597	824	265	310	923	768	573	196	23
38	948	301	625	816	292	301	951	758	600	186	22
39	976	293	652	807	320	293	979	749	627	176	21
40	.27004	96285	.28680								
41	032	277	708								
42	060	269	736								
43	088	261	764								
44	116	253	792								
45	27144	.96246	.28820								
46	172	238	847								
47	200	230	875								
48	228	222	903								
49	256	214	931								
50	.27284	.96206	.28959								
51	312	198	987								
52	340	190	.29015								
53	368	182	042								
54	396	174	070								
55	27424	.96166	.29098								
56	452	158	126								
57	480	150	154								
58	508	142	182								
59	536	134	209								
60	.27564	.96126	.29237								
	Cos. 74°	Sin. 74°	Cos. 73								

M.	20° Sin.	20° Cos.	21° Sin.	21° Cos.	22° Sin.	22° Cos.	23° Sin.	23° Cos.	24° Sin.	24° Cos.	
0	.34202	.93969	.35837	.93358	.37461	.92718	.39073	.92050	40674	.91355	60
1	229	959	864	348	488	707	100	039	700	343	59
2	257	949	891	337	515	697	127	028	727	331	58
3	284	939	918	327	542	686	153	016	753	319	57
4	311	929	946	316	569	675	180	005	780	307	56
5	.34339	.93919	.35973	.93306	.37595	.92664	.39207	.91994	.40806	.91295	55
6	366	909	.36000	295	622	653	234	982	833	283	54
7	393	899	027	285	649	642	260	971	860	272	53
8	421	889	054	274	676	631	287	959	886	260	52
9	448	879	081	264	703	620	314	948	913	248	51
10	.34475	.93869	.36108	.93253	.37730	.92609	.39341	.91936	.40939	.91236	50
11	503	859	135	243	757	[illegible]8	367	925	966	224	49
12	530	849	162	232	784	[illegible]7	394	914	992	212	48
13	557	839	190	222	811	[illegible]6	421	902	.41019	200	47
14	584	829	217	211	838	[illegible]5	448	891	045	188	46
15	.34612	.93819	.36244	.93201	.37865	[illegible]4	.39474	.91879	.41072	.91176	45
16	639	809	271	190	892	[illegible]3	501	868	098	164	44
17	666	799	298	180	919	[illegible]2	528	856	125	152	43
18	694	789	325	169	946	[illegible]1	555	845	151	140	42
19	721	779	352	159	973	[illegible]0	581	833	178	128	41
20	34748	.93769	.36379	.93148	.37999	[illegible]9	.39608	.91822	.41204	.91116	40
21	775	759	406	137	.38026	[illegible]8	635	810	231	104	39
22	803	748	434	127	053	[illegible]7	661	799	257	092	38
23	830	738	461	116	080	[illegible]6	688	787	284	080	37
24	857	728	488	106	107	[illegible]5	715	775	310	068	36
25	.34884	.93718	.36515	.93095	.38134	.92444	.39741	.91764	.41337	.91056	35
26	912	708	542	084	161	432	768	752	363	044	34
27	939	698	569	074	188	421	795	741	390	032	33
28	966	688	596	063	215	410	822	729	416	020	32
29	993	677	623	052	241	399	848	718	443	008	31
30	.35021	.93667	.36650	.93042	.38268	.92388	.39875	.91706	.41469	.90996	30
31	048	657	677	031	295	377	902	694	496	984	29
32	075	647	704	020	322	366	928	683	522	972	28
33	102	637	731	010	349	355	955	671	549	960	27
34	130	626	758	.92999	376	343	982	660	575	948	26
35	.35157	.93616	.36785	.92988	.38403	.92332	.40008	.91648	.41602	.90936	25
36	184	606	812	978	430	321	035	636	628	924	24
37	211	596	839	967	456	310	062	625	655	911	23
38	239	585	867	956	483	299	088	613	681	899	22
[illegible]	266	575	894	945	510	287	115	601	707	887	21
40	.35293	.93565	.36921	.92935	.38537	.92276	.40141	.91590	.41734	.90875	20
41	320	555	948	924	564	265	168	578	760	863	19
42	347	544	975	913	591	254	195	566	787	851	[illegible]
43	375	534	.37002	902	617	243	221	555	813	839	17
44	402	524	029	892	644	231	248	543	840	826	16
45	.35429	.93514	.37056	.92881	.38671	.92220	.40275	.91531	.41866	.90814	15
46	456	503	083	870	698	209	301	519	892	802	14
47	484	493	110	859	725	198	328	508	919	790	13
48	511	483	137	849	752	186	355	496	945	778	12
[illegible]	538	472	164	838	778	175	381	484	972	766	11
50	.35565	.93462	37191	.92827	.38805	.92164	.40408	.91472	.41998	.90753	10
51	592	452	218	816	832	152	434	461	.42024	741	9
52	619	441	245	805	859	141	461	449	051	729	8
53	647	431	272	794	886	130	488	437	077	717	7
54	674	420	299	784	912	119	514	425	104	704	6
55	.35701	.93410	.37326	.92773	.38939	.92107	.40541	.91414	.42130	.90692	5
56	728	400	353	762	966	096	567	402	156	680	4
57	755	389	380	751	993	085	594	390	183	668	3
58	782	379	407	740	.39020	073	621	378	209	655	2
59	810	368	434	729	046	062	647	366	235	643	1
60	.35837	.93358	.37461	.92718	.39073	.92050	.40674	91355	42262	.90631	0

			26°		27°		28°		29°		
		ı.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	
0	.42262	.90631	.43837	.89879	.45399	.89101	.46947	.88295	.48481	.87462	60
1	288	618	863	867	425	087	973	281	506	448	59
2	315	606	889	854	451	074	999	267	532	434	58
3	341	594	916	841	477	061	.47024	254	557	420	57
4	367	582	942	828	503	048	050	240	583	406	56
5	.42394	.90569	43968	.89816	.45529	.89035	.47076	.88226	.48608	.87391	55
6	420	557	994	803	554	021	101	213	634	377	54
7	446	545	.44020	790	580	008	127	199	659	363	53
8	473	532	046	777	606	.88995	153	185	684	349	52
9	499	520	072	764	632	981	178	172	710	335	51
10	.42525	.90507	.44098	.89752	.45658	.88968	.47204	.88158	.48735	.87321	50
11	552	495	124	739	684	955	229	144	761	306	49
12	578	483	151	726	710	942	255	130	786	292	48
13	604	470	177	713	736	928	281	117	811	278	47
14	631	458	203	700	762	915	306	103	837	264	46
15	.42657	.90446	.44229	.89687	.45787	88902	.47332	.88089	.48862	.87250	45
16	683	433	255	674	813	888	358	075	888	235	44
17	709	421	281	662	839	875	383	062	913	221	43
18	736	408	307	649	865	862	409	048	938	207	42
19	762	396	333	636	891	848	434	034	964	193	41
20	.42788	.90383	.44359	89623	.45917	.88835	.47460	.88020	.48989	.87178	40
21	815	371	385	610	942	822	486	006	.49014	164	39
22	841	358	411	597	968	808	511	.87993	040	150	38
23	867	346	437	584	994	795	537	979	065	136	37
24	894	334	464	571	46020	782	562	965	090	121	36
25	.42920	90321	.44490	.89558	.46046	.88768	.47588	.87951	.49116	.87107	35
26	946	309	516	545	072	755	614	937	141	093	34
27	972	296	542	532	097	741	639	923	166	079	33
28	999	284	568	519	123	728	665	909	192	064	32
29	.43025	271	594	506	149	715	690	896	217	050	31
30	.43051	90259	.44620	.89493	.46175	.88701	.47716	.87882	.49242	.87036	30
31	077	246	646	480	201	688	741	868	268	021	29
32	104	233	672	467	226	674	767	854	293	007	28
33	130	221	698	454	252	661	793	840	318	.86993	27
34	156	208	724	441	278	647	818	826	344	978	26
35	.43182	.90196	.44750	.89428	.46304	.88634	.47844	.87812	.49369	.86964	25
36	209	[illegible]3	776	415	330	620	869	798	394	949	24
37	235	[illegible]1	802	402	355	607	895	784	419	935	23
38	261	[illegible]8	828	389	381	593	920	770	445	921	22
39	287	[illegible]6	854	376	407	580	946	756	470	906	21
40	.43313	.[illegible]3	.44880	.89363	.46433	.88566	.47971	.87743	.49495	.86892	20
41	340	[illegible]0	906	350	458	553	997	729	521	878	19
42	366	[illegible]8	932	337	484	539	.48022	715	546	863	18
43	392	[illegible]5	958	324	510	526	048	701	571	849	17
44	418	[illegible]2	984	311	536	512	073	687	596	834	16
45	.43445	.[illegible]0	.45010	.89298	.46561	.88499	.48099	.87673	.49622	.86820	15
46	471	[illegible]7	036	285	587	485	124	659	647	805	14
47	497	[illegible]5	062	272	613	472	150	645	672	791	13
48	523	[illegible]2	088	259	639	458	175	631	697	777	12
49	549	[illegible]9	114	245	664	445	201	617	723	762	11
50	.43575	.[illegible]7	.45140	.89232	.46690	88431	.48226	.87603	.49748	.86748	10
51	602	.[illegible]4	166	219	716	417	252	589	773	733	9
52	628	[illegible]1	192	206	742	404	277	575	798	719	8
53	654	[illegible]8	218	193	767	390	303	561	824	704	7
54	680	[illegible]6	243	180	793	377	328	546	849	690	6
55	.43706	.[illegible]3	.45269	.89167	.46819	.88363	.48354	.87532	.49874	86675	5
56	733	[illegible]0	295	153	844	349	379	518	899	661	4
57	759	[illegible]8	321	140	870	336	405	504	924	646	3
58	785	[illegible]5	347	127	896	322	430	490	950	632	2
59	811	[illegible]2	373	114	921	308	456	476	975	617	1
60	.43837	.[illegible]9	.45399	.89101	46947	.88295	.48481	.87462	.50000	.86603	0
-	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos	[illegible]	[illegible]	[illegible]	
	64°		63°		62°		[illegible]		[illegible]		

TABLE XVII.—NATURAL SINES AND COSINES.

M	30° Sin.	30° Cos.	31° Sin.	31° Cos.	32° Sin.	32° Cos.	33° Sin.	33° Cos.	34° Sin.	34° Cos.	
0	.50000	.86603	.51504	[illegible]	.52992	[illegible]	.54464	.83867	.55919	.82904	60
1	025	588	529	[illegible]	.53017	[illegible]	488	851	943	887	59
2	050	573	554	[illegible]	041	[illegible]	513	835	968	871	58
3	076	559	579	[illegible]	066	[illegible]	537	819	992	855	57
4	101	544	604	[illegible]	091	[illegible]	561	[redacted]	.56016	839	56
5	.50126	.86530	.51628	[illegible]	.53115	[illegible]	.54586	.83788	.56040	.82822	55
6	151	515	653	[illegible]	140	[illegible]	610	772	064	806	54
7	176	501	678	[illegible]	164	[illegible]	635	756	088	[redacted]	53
8	201	486	703	[illegible]	189	[illegible]	659	740	112	773	52
9	227	471	728	[illegible]	214	[illegible]	683	724	136	757	51
10	.50252	86457	.51753	[illegible]	.53238	[illegible]	.54708	.83708	.56160	.82741	50
11	277	442	778	[illegible]	263	[illegible]	732	692	184	724	49
12	302	427	803	[illegible]	288	[illegible]	756	676	208	708	48
13	327	413	828	[illegible]	312	[illegible]	781	660	232	692	47
14	352	398	852	[illegible]	337	[illegible]	805	645	256	675	46
15	.50377	.86384	.51877	[illegible]	.53361	[illegible]	.54829	.83629	.56280	.82659	45
16	403	369	902	[illegible]	386	[illegible]	854	613	305	643	44
17	428	354	927	[illegible]	411	[illegible]	878	597	329	626	43
18	453	340	952	[illegible]	435	[illegible]	902	581	353	610	42
19	478	325	977	[illegible]	460	[illegible]	927	565	377	593	41
20	.50503	.86310	52002	[illegible]	.53484	[illegible]	.54951	.83549	.56401	.82577	40
21	528	295	026	[illegible]	509	[illegible]	975	533	425	561	39
22	553	281	051	[illegible]	534	[illegible]	999	517	449	544	38
23	578	266	076	[illegible]	558	[illegible]	.55024	501	473	528	37
24	603	251	101	[illegible]	583	[illegible]	048	485	497	511	36
25	.50628	.86237	.52126	[illegible]	.53607	[illegible]	.55072	.83469	.56521	.82495	35
26	654	222	151	[illegible]	632	[illegible]	097	453	[redacted]	478	34
27	679	207	175	[illegible]	656	[illegible]	121	437	569	462	33
28	704	192	200	[illegible]	681	[illegible]	145	421	593	446	32
29	729	178	225	[illegible]	705	[illegible]	169	405	617	429	31
30	.50754	.86163	.52250	.85264	53730	[illegible]	.55194	.83389	.56641	.82413	[redacted]
31	779	148	275	249	754	[illegible]	218	373	665	396	29
32	804	133	299	234	779	[illegible]	242	356	689	380	28
33	829	119	324	218	804	[illegible]	266	340	713	363	27
34	854	104	349	203	828	[illegible]	291	324	736	347	26
35	.50879	.86089	.52374	.85188	.53853	[illegible]	.55315	.83308	.56760	.82330	25
36	904	074	399	173	877	[illegible]	339	292	784	314	24
37	929	059	423	157	902	[illegible]	363	276	808	297	23
38	954	045	448	142	926	214	388	260	832	281	22
39	979	030	473	127	951	198	412	244	856	264	21
40	.51004	.86015	.52498	.85112	.53975	.84182	.55436	.83228	.56880	.82248	20
41	029	000	522	096	.54000	167	460	212	904	231	19
42	054	.85985	547	081	024	151	484	195	928	214	18
43	079	970	572	066	049	135	509	179	952	198	17
44	104	956	597	051	073	120	533	163	976	181	16
45	.51129	.85941	.52621	.85035	.54097	.84104	.55557	.83147	.57000	.82165	15
46	154	926	646	020	122	088	581	131	024	148	14
47	179	911	671	005	146	072	605	115	047	132	13
48	204	896	696	.84989	171	057	630	098	071	115	12
49	229	881	720	974	195	041	654	082	095	098	11
50	.51254	.85866	.52745	.84959	.54220	.84025	.55678	.83066	.57119	.82082	10
51	279	851	770	943	244	009	702	050	143	065	9
52	304	836	794	928	269	.83994	726	034	167	048	8
53	329	821	819	913	293	978	750	017	191	032	7
54	354	806	844	897	317	962	775	001	215	015	6
55	.51379	.85792	.52869	.84882	54342	.83946	.55799	.82985	.57238	.81999	5
56	404	777	893	866	366	930	823	969	262	982	4
57	429	762	918	851	391	915	847	953	286	965	3
58	454	747	943	836	415	899	871	936	310	949	2
59	479	732	967	820	440	883	895	920	334	932	1
60	.51504	.85717	.52992	.84805	54464	.83867	55919	.82904	.57358	.81915	0
						Sin. 7°	Cos.	[redacted] [redacted]6°	Cos.	Sin. 55°	M.

TABLE XVII.—NATURAL SINES AND COSINES.

M.	35° Sin.	35° Cos.	36° Sin.	36° Cos.	37° Sin.	37° Cos.	38° Sin.	38° Cos.	39° Sin.	39° Cos.	
			79	.80902	.60182	.79864	.61566	.78801	.62932	.77715	60
			02	885	205	846	589	783	955	696	59
			26	867	228	829	612	765	977	678	58
			49	850	251	811	635	747	.63000	660	57
			73	833	274	793	658	729	022	641	56
			96	.80816	.60298	.79776	.61681	.78711	.63045	.77623	55
			20	799	321	758	704	[illegible]	068	605	54
			43	782	344	741	726	676	090	586	53
			67	765	367	723	749	658	113	[illegible]	52
			90	748	390	706	772	640	135	550	51
			14	.80730	.60414	.79688	.61795	.78622	.63158	.77531	50
			37	713	437	671	818	604	180	513	49
			61	696	460	653	841	586	203	[illegible]	48
			84	679	483	635	864	568	225	476	47
			08	662	506	618	887	550	248	458	46
			31	.80644	.60529	.79600	.61909	.78532	.63271	.77439	45
			54	627	553	583	932	514	293	421	44
			78	610	576	565	955	496	316	402	43
			01	593	599	547	978	478	338	384	42
			25	576	622	530	.62001	460	361	366	41
			48	.80558	.60645	.79512	.62024	.78442	.63383	.77347	40
			72	541	668	494	046	424	406	329	39
			95	524	691	477	069	405	428	310	38
			18	507	714	459	092	387	451	292	37
			42	489	738	441	115	369	473	273	36
			65	.80472	.60761	.79424	.62138	.78351	.63496	.77255	35
			89	455	784	406	160	333	518	236	34
			12	438	807	388	183	315	540	218	33
			36	420	830	371	206	297	563	199	32
			59	403	853	353	229	279	585	181	31
			82	.80386	.60876	.79335	.62251	.78261	.63608	.77162	30
			06	368	899	318	274	243	630	144	29
			29	351	922	300	297	225	653	125	28
			52	334	945	282	320	206	675	107	27
			76	316	968	264	342	188	698	088	26
			99	.80299	.60991	.79247	.62365	.78170	63720	.77070	25
			22	282	.61015	229	388	152	742	051	24
			46	264	038	211	411	134	765	033	23
			69	247	061	193	433	116	787	014	22
			93	230	084	176	456	098	810	.76996	21
			16	.80212	.61107	.79158	62479	.78079	.63832	.76977	20
			39	195	130	140	502	061	854	959	19
			63	178	153	122	524	043	877	940	18
			86	160	176	105	547	025	899	921	17
			09	143	199	087	570	007	922	903	16
			32	.80125	.61222	.79069	.62592	.77988	.63944	.76884	15
			56	108	245	051	615	970	966	866	14
			79	091	268	033	638	952	989	847	13
			02	073	291	016	660	[illegible]	.64011	828	12
			26	056	314	.78998	683	916	033	810	11
			49	.80038	.61337	.78980	62706	.77897	.64056	.76791	10
			72	021	360	962	728	879	078	772	9
			95	003	383	944	751	861	100	754	8
			19	.79986	406	926	774	843	123	735	7
			42	968	429	908	796	824	145	717	6
			65	.79951	.61451	.78891	.62819	.77806	.64167	.76698	5
			89	934	474	873	842	788	190	679	[illegible]
			12	916	497	855	864	769	212	661	3
			35	899	520	837	887	751	234	642	2
			58	881	543	819	909	733	256	623	1
			82	.79864	61566	.78801	.62932	.77715	.64279	.76604	0
			e.	Sin.	Cos.	Sin.	Cos.	S			
			53°		52°		1°				

M.	40° Sin.	40° Cos.	41° Sin.	41° Cos.	42° Sin.	42° Cos.	43° Sin.	43° Cos.	44° Sin.	44° Cos.	
0	.64279	.76604	.65606	.75471	.66913	.74314	.68200	.73135	.69466	.71934	60
1	301	586	628	452	935	295	221	116	487	914	59
2	323	567	650	433	956	276	242	096	508	894	58
3	346	548	672	414	978	256	264	076	529	873	57
4	368	530	694	395	999	237	285	056	549	853	56
5	.64390	.76511	.65716	.75375	.67021	.74217	.68306	.73036	.69570	.71833	55
6	412	492	738	356	043	198	327	016	591	813	54
7	435	473	759	337	064	178	349	.72996	612	792	53
8	457	455	781	318	086	159	370	976	633	772	52
9	479	436	803	299	107	139	391	957	654	752	51
10	.64501	.76417	.65825	.75280	.67129	.74120	.68412	.72937	.69675	.71732	50
11	524	398	847	261	151	100	434	917	696	711	49
12	546	380	869	241	172	080	455	897	717	691	48
13	568	361	891	222	194	061	476	877	737	671	47
14	590	342	913	203	215	041	497	857	758	650	46
15	.64612	.76323	.65935	.75184	.67237	.74022	.68518	.72837	.69779	.71630	45
16	635	304	956	165	258	002	539	817	800	610	44
17	657	286	978	146	280	.73983	561	797	821	590	43
18	679	267	.66000	126	301	963	582	777	842	569	42
19	701	248	022	107	323	944	603	757	862	549	41
20	.64723	.76229	.66044	.75088	.67344	.73924	.68624	.72737	.69883	.71529	40
21	746	210	066	069	366	904	645	717	904	508	39
22	768	192	088	050	387	885	666	697	925	488	38
23	790	173	109	030	409	865	688	677	946	468	37
24	812	154	131	011	430	846	709	657	966	447	36
25	.64834	.76135	.66153	.74992	.67452	.73826	.68730	.72637	.69987	.71427	35
26	856	116	175	973	473	806	751	617	.70008	407	34
27	878	097	197	953	495	787	772	597	029	386	33
28	901	078	218	934	516	767	793	577	049	366	32
29	923	059	240	915	538	747	814	557	070	345	31
30	.64945	.76041	.66262	.74896	.67559	.73728	.68835	.72537	.70091	.71325	30
31	967	022	284	876	580	708	857	517	112	305	29
32	989	003	306	857	602	688	878	497	132	284	28
33	.65011	.75984	327	838	623	669	899	477	153	264	27
34	033	965	349	818	645	649	920	457	174	243	26
35	.65055	.75946	.66371	.74799	.67666	.73629	.68941	.72437	.70195	.71223	25
36	077	927	393	780	688	610	962	417	215	203	24
37	100	908	414	760	709	590	983	397	236	182	23
38	122	889	436	741	730	570	.69004	377	257	162	22
39	144	870	458	722	752	551	025	357	277	141	21
40	.65166	.75851	.66480	.74703	.67773	.73531	.69046	.72337	.70298	.71121	20
41	188	832	501	683	795	511	067	317	319	100	19
42	210	813	523	664	816	491	088	297	339	080	18
43	232	794	545	644	837	472	109	277	360	059	17
44	254	775	566	625	859	452	130	257	381	039	16
45	.65276	.75756	.66588	.74606	.67880	.73432	.69151	.72236	.70401	.71019	15
46	298	738	610	586	901	413	172	216	422	.70998	14
47	320	719	632	567	923	393	193	196	443	978	13
48	342	700	653	548	944	373	214	176	463	957	12
49	364	680	675	528	965	353	235	156	484	937	11
50	.65386	.75661	.66697	.74509	.67987	.73333	.69256	.72136	.70505	.70916	10
51	408	642	718	489	.68008	314	277	116	525	896	9
52	430	623	740	470	029	294	298	095	546	875	8
53	452	604	762	451	051	274	319	075	567	855	7
54	474	585	783	431	072	254	340	055	587	834	6
55	.65496	.75566	.66805	.74412	.68093	.73234	.69361	.72035	.70608	.70813	5
56	518	547	827	392	115	215	382	015	628	793	4
57	540	528	848	373	136	195	403	.71995	649	772	3
58	562	509	870	353	157	175	424	974	670	752	2
59	584	490	891	334	179	155	445	954	690	731	1
60	.65606	.75471	.66913	.74314	.68200	.73135	.69466	.71934	.70711	.70711	0
	Cos. 49°	Sin. 49°	Cos. 48°	Sin. 48°	Cos. 47°	Sin. 47°	Cos. 46°	Sin. 46°	Cos. 45°	Sin. 45°	M.

M.	0°		1°		2°		3°		
	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	
0	.00000	∞	.01746	57.2900	.03492	28.6363	.05241	19.0811	60
1	029	3437.75	775	56.3506	521	.3994	270	.8 755	59
2	058	1718.87	804	55.4415	550	.1664	299	711	58
3	087	1145.92	833	54.5613	579	27.9372	328	678	57
4	116	859.436	862	53.7086	609	.7117	357	656	56
5	.00145	687.549	.01891	52.8821	.03638	27.4899	.05387	645	55
6	175	572.957	920	52.0807	667	.2715	416	645	54
7	204	491.106	949	51.3032	696	.0566	445	655	53
8	233	429.718	978	50.5485	725	26.8450	474	677	52
9	262	381.971	.02007	49.8157	754	.6367	503	708	51
10	.00291	343.774	.02036	49.1039	.03783	26.4316	.05533	18.0750	50
11	320	312.521	066	48.4121	812	.2296	562	17.9802	49
12	349	286.478	095	47.7395	842	.0307	591	.8863	48
13	378	264.441	124	47.0853	871	25.8348	620	.7934	47
14	407	245.552	153	46.4489	900	.6418	649	.7015	46
15	.00436	229.182	.02182	45.8294	.03929	25.4517	.05678	17.6106	45
16	465	214.858	211	45.2261	958	.2644	708	.5205	44
17	495	202.219	240	44.6386	987	.0798	737	.4314	43
18	524	190.984	269	44.0661	.04016	24.8978	766	.3432	42
19	553	180.932	298	43.5081	046	.7185	795	.2558	41
20	.00582	171.885	.02328	42.9641	.04075	24.5418	.05824	17 693	40
21	611	163.700	357	42.4335	104	3675	854	837	39
22	640	156.259	386	41.9158	133	.1957	883	16 990	38
23	669	149.465	415	41.4106	162	.0263	912	150	37
24	698	143.237	444	40.9174	191	23.8593	941	319	36
25	.00727	137.507	.02473	40.4358	.04220	23.6945	.05970	16 496	35
26	756	132.219	502	39.9655	250	.5321	999	681	34
27	785	127.321	531	39.5059	279	.3718	.06029	874	33
28	815	122.774	560	39.0568	308	.2137	058	075	32
29	844	118.540	589	38.6177	337	.0577	087	283	31
30	.00873	114.589	.02619	38.1885	.04366	22.9038	.06116	16.3499	30
31	902	110.892	648	37.7686	395	.7519	145	.2722	29
32	931	107.426	677	37.3579	424	.6020	175	.1952	28
33	960	104.171	706	36.9560	454	.4541	204	.1190	27
34	989	101.107	735	36.5627	483	.3081	233	.0435	26
35	.01018	98.2179	.02764	36.1776	.04512	22.1640	.06262	15.9687	25
36	047	95.4895	793	35.8006	541	.0217	291	.8945	24
37	076	92.9085	822	35.4313	570	21.8813	321	.8211	23
38	105	90.4633	851	35.0695	599	.7426	350	.7483	22
39	135	88.1436	881	34.7151	628	.6056	379	.6762	21
40	.01164	85.9398	.02910	34.3678	.04658	21.4704	.06408	15.6048	20
41	193	83.8435	939	34.0273	687	.3369	438	.5340	19
42	222	81.8470	968	33.6935	716	.2049	467	.4638	18
43	251	79.9434	997	33.3662	745	.0747	496	.3943	17
44	280	78.1263	.03026	33.0452	774	20.9460	525	.3254	16
45	.01309	76.3900	.03055	32.7303	.04803	20.8188	.06554	15.2571	15
46	338	74.7292	084	32.4213	833	.6932	584	.1893	14
47	367	73.1390	114	32.1181	862	.5691	613	.1222	13
48	396	71.6151	143	31.8205	891	.4465	642	.0557	12
49	425	70.1533	172	31.5284	920	.3253	671	14.9898	11
50	.01455	68.7501	.03201	31.2416	.04949	20.2056	.06700	14.9244	10
51	484	67.4019	230	30.9599	978	.0872	730	.8596	9
52	513	66.1055	259	30.6833	.05007	19.9702	759	.7954	8
53	542	64.8580	288	30.4116	037	.8546	788	.7317	7
54	571	63.6567	317	30.1446	066	.7403	817	.6685	6
55	.01600	62.4992	.03346	29.8823	.05095	19.6273	.06847	14.6059	5
56	629	61.3829	376	29.6245	124	.5156	876	.5438	4
57	658	60.3058	405	29.3711	153	.4051	905	.4823	3
58	687	59.2659	434	29.1220	182	.2959	934	.4212	2
59	716	58.2612	463	28.8771	212	.1879	963	.3607	1
60	.01746	57.2900	.03492	28.6363	05241	19.0811	.06993	14.3007	0

M.	4° Tan.	4° Cot.	5° Tan.	5° Cot.	6° Tan.	6° Cot.	7° Tan.	7° Cot.	
0	.06993	14.3007	.08749	11.4301	.10510	9.51436	.12278	8.14435	60
1	.07022	.2411	778	.3919	540	.48781	308	.12481	59
2	051	.1821	807	.3540	569	.46141	338	.10536	58
3	080	.1235	837	.3163	599	.43515	367	.08600	57
4	110	.0655	866	.2789	628	.40904	397	.06674	56
5	.07139	14.0079	.08895	11.2417	.10657	9.38307	.12426	8.04756	55
6	168	13.9507	925	.2048	687	.35724	456	.02848	54
7	197	.8940	[illegible]	.1681	716	.33155	485	.00948	53
8	227	.8378	983	.1316	746	.30599	515	7.99058	52
9	256	.7821	.09013	.0954	775	.28058	544	.97176	51
10	.07285	13.7267	.09042	11.0594	.10805	9.25530	.12574	7.95302	50
11	314	.6719	071	.0237	834	.23016	603	.93438	49
12	344	.6174	101	10.9882	863	.20516	633	.91582	48
13	373	.5634	130	.9529	893	.18028	662	.89734	47
14	402	.5098	159	.9178	922	.15554	692	.87895	46
15	.07431	13.4566	.09189	10.8829	.10952	9.13093	.12722	7.86064	45
16	461	.4039	218	.8483	981	.10646	751	.84242	44
17	490	.3515	247	.8139	.11011	.08211	781	.82428	43
18	519	.2996	277	.7797	040	.05789	810	.80622	42
19	548	.2480	306	.7457	070	.03379	840	.78825	41
20	.07578	13.1969	.09335	10.7119	.11099	9.00983	.12869	7.77035	40
21	607	.1461	365	.6783	128	8.98598	899	.75254	39
22	636	.0958	394	.6450	158	.96227	929	.73480	38
23	665	.0458	423	.6118	187	.93867	958	.71715	37
24	695	12.9962	453	.5789	217	.91520	988	.69957	36
25	.07724	12.9469	.09482	10.5462	.11246	8.89185	.13017	7.68208	35
26	753	.8981	511	.5136	276	.86862	047	.66466	34
27	782	.8496	541	.4813	305	.84551	076	.64732	33
28	812	.8014	570	.4491	335	.82252	106	.63005	32
29	841	.7536	600	.4172	364	.79964	136	.61287	31
30	.07870	12.7062	.09629	10.3854	.11394	8.77689	.13165	7.59575	30
31	899	.6591	658	.3538	423	.75425	195	.57872	29
32	929	.6124	688	.3224	452	.73172	224	.56176	28
33	958	.5660	717	.2913	482	.70931	254	.54487	27
34	987	.5199	746	.2602	511	.68701	284	.52806	26
35	.08017	12.4742	.09776	10.2294	.11541	8.66482	.13313	7.51132	25
36	046	.4288	805	.1988	570	.64275	343	.49465	24
37	075	.3838	834	.1683	600	.62078	372	.47806	23
38	104	.3390	864	.1381	629	.59893	402	.46154	22
39	134	.2946	893	.1080	659	.57718	432	.44509	21
40	.08163	12.2505	.09923	10.0780	.11688	8.55555	.13461	7.42871	20
41	192	.2067	952	.0483	718	.53402	491	.41240	[illegible]
42	221	.1632	981	.0187	747	.51259	521	.39616	18
43	251	.1201	.10011	9.98931	777	.49128	550	.37999	17
44	280	.0772	040	.96007	806	.47007	580	.36389	16
45	.08309	12.0346	.10069	9.93101	.11836	8.44896	.13609	7.34786	15
46	339	11.9923	099	.90211	865	.42795	639	.33190	14
47	368	.9504	128	.87338	895	.40705	669	.31600	13
48	397	.9087	158	.84482	924	.38625	698	.30018	12
49	427	.8673	187	.81641	954	.36555	728	.28442	11
50	.08456	11.8262	.10216	9.78817	.11983	8.34496	.13758	7.26873	10
51	485	.7853	246	.76009	.12013	.32446	787	.25310	9
52	514	.7448	275	.73217	042	.30406	817	.23754	8
53	544	.7045	305	.70441	072	.28376	846	.22204	7
54	573	.6645	334	.67680	101	.26355	876	.20661	6
55	.08602	11.6248	.10363	9.64935	.12131	8.24345	.13906	7.19125	5
56	632	.5853	393	.62205	160	.22344	935	.17594	4
57	661	.5461	422	.59490	190	.20352	965	.16071	3
58	690	.5072	452	.56791	219	.18370	995	.14553	2
59	720	.4685	481	.54106	249	.16398	.14024	.13042	1
60	.08749	11.4301	.10510	9.51436	.12278	8.14435	.14054	7.11537	0
	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	

M.	8° Tan.	8° Cot.	9° Tan.	9° Cot.	10° Tan.	10° Cot.	11° Tan.	11° Cot.	
0	.14054	7.11537	.15838	6.31375	.17633	5.67128	.19438	5.14455	60
1	084	.10038	868	.30189	663	.66165	468	.13658	59
2	113	.08546	898	.29007	693	.65205	498	.12862	58
3	143	.07059	928	.27829	723	.64248	529	.12069	57
4	173	.05579	958	.26655	753	.63295	559	.11279	56
5	.14202	7.04105	.15988	6.25486	.17783	5.62344	.19589	5.10490	55
6	232	.02637	.16017	.24321	813	.61397	619	.09704	54
7	262	.01174	047	.23160	843	.60452	649	.08921	53
8	291	6.99718	077	.22003	873	.59511	680	.08139	52
9	321	.98268	107	.20851	903	.58573	710	.07360	51
10	.14351	6.96823	.16137	6.19703	.17933	5.57638	.19740	5.06584	50
11	381	.95385	167	.18559	963	.56706	770	.05809	49
12	410	.93952	196	.17419	993	.55777	801	.05037	48
13	440	.92525	226	.16283	.18023	.54851	831	.04267	47
14	470	.91104	256	.15151	053	.53927	861	.03499	46
15	.14499	6.89688	.16286	6.14023	.18083	5.53007	.19891	5.02734	45
16	529	.88278	316	.12899	113	.52090	921	.01971	44
17	559	.86874	346	.11779	143	.51176	952	.01210	43
18	588	.85475	376	.10664	173	.50264	982	.00451	42
19	618	.84082	405	.09552	203	.49356	.20012	4.99695	41
20	.14648	6.82694	.16435	6.08444	.18233	5.48451	.20042	4.98940	40
21	678	.81312	465	.07340	263	.47548	073	.98188	39
22	707	.79936	495	.06240	293	.46648	103	.97438	38
23	737	.78564	525	.05143	323	.45751	133	.96690	37
24	767	.77199	555	.04051	353	.44857	164	.95945	36
25	.14796	6.75838	.16585	6.02962	.18384	5.43966	.20194	4.95201	35
26	826	.74483	615	.01878	414	.43077	224	.94460	34
27	856	.73133	645	.00797	444	.42192	254	.93721	33
28	886	.71789	674	5.99720	474	.41309	285	.92984	32
29	915	.70450	704	.98646	504	.40429	315	.92249	31
30	.14945	6.69116	.16734	5.97576	.18534	5.39552	.20345	4.91516	30
31	975	.67787	764	.96510	564	.38677	376	.90785	29
32	.15005	.66463	794	.95448	594	.37805	406	.90056	28
33	034	.65144	824	.94390	624	.36936	436	.89330	27
34	064	.63831	854	.93335	654	.36070	466	.88605	26
35	.15094	6.62523	.16884	5.92283	.18684	5.35206	.20497	4.87882	25
36	124	.61219	914	.91236	714	.34345	527	.87162	24
37	153	.59921	944	.90191	745	.33487	557	.86444	23
38	183	.58627	974	.89151	775	.32631	588	.85727	22
39	213	.57339	.17004	.88114	805	.31778	618	.85013	21
40	.15243	6.56055	.17033	5.87080	.18835	5.30928	.20648	4.84300	20
41	272	.54777	063	.86051	865	.30080	679	.83590	19
42	302	.53503	093	.85024	895	.29235	709	.82882	18
43	332	.52234	123	.84001	925	.28393	739	.82175	17
44	362	.50970	153	.82982	955	.27553	770	.81471	16
45	.15391	6.49710	.17183	5.81966	.18986	5.26715	.20800	4.80769	15
46	421	.48456	213	.80953	.19016	.25880	830	.80068	14
47	451	.47206	243	.79944	046	.25048	861	.79370	13
48	481	.45961	273	.78938	076	.24218	891	.78673	12
49	511	.44720	303	.77936	106	.23391	921	.77978	11
50	.15540	6.43484	.17333	5.76937	.19136	5.22566	.20952	4.77286	10
51	570	.42253	363	.75941	166	.21744	982	.76595	9
52	600	.41026	393	.74949	197	.20925	.21013	.75906	8
53	630	.39804	423	.73960	227	.20107	043	.75219	7
54	660	.38587	453	.72974	257	.19293	073	.74534	6
55	.15689	6.37374	.17483	5.71992	.19287	5.18480	.21104	4.73851	5
56	719	.36165	513	.71013	317	.17671	134	.73170	4
57	749	.34961	543	.70037	347	.16863	164	.72490	3
58	779	.33761	573	.69064	378	.16058	195	.71813	2
59	809	.32566	603	.68094	408	.15256	225	.71137	1
60	.15838	6.31375	.17633	5.67128	.19438	5.14455	.21256	4.70463	0
	81° Cot.	81° Tan.	80° Cot.	80° Tan.	79° Cot.	79° Tan.	78° Cot.	78° Tan.	M.

M.	12° Tan.	12° Cot.	13° Tan.	13° Cot.	14° Tan.	14° Cot.	15° Tan.	15° Cot.	
0	.21256	4.70463	.23087	4.33148	.24933	4.01078	.26795	3.73205	60
1	286	.69791	117	.32573	964	.00582	826	.72771	59
2	316	.69121	148	.32001	995	.00086	857	.72338	58
3	347	.68452	179	.31430	.25026	3.99592	888	.71907	57
4	377	.67786	209	.30860	056	.99099	920	.71476	56
5	.21408	4.67121	.23240	4.30291	.25087	3.98607	.26951	3.71046	55
6	438	.66458	271	.29724	118	.98117	982	.70616	54
7	469	.65797	301	.29159	149	.97627	.27013	.70188	53
8	499	.65138	332	.28595	180	.97139	044	.69761	52
9	529	.64480	363	.28032	211	.96651	076	.69335	51
10	.21560	4.63825	.23393	4.27471	.25242	3.96165	.27107	3.68909	50
11	590	.63171	424	.26911	273	.95680	138	.68485	49
12	621	.62518	455	.26352	304	.95196	169	.68061	48
13	651	.61868	485	.25795	335	.94713	201	.67638	47
14	682	.61219	516	.25239	366	.94232	232	.67217	46
15	.21712	4.60572	.23547	4.24685	.25397	3.93751	.27263	3.66796	45
16	743	.59927	578	.24132	428	.93271	294	.66376	44
17	773	.59283	608	.23580	459	.92793	326	.65957	43
18	804	.58641	639	.23030	490	.92316	357	.65538	42
19	834	.58001	670	.22481	521	.91839	388	.65121	41
20	.21864	4.57363	.23700	4.21933	.25552	3.91364	.27419	3.64705	40
21	895	.56726	731	.21387	583	.90890	451	.64289	39
22	925	.56091	762	.20842	614	.90417	482	.63874	38
23	956	.55458	793	.20298	645	.89945	513	.63461	37
24	986	.54826	823	.19756	676	.89474	545	.63048	36
25	.22017	4.54196	.23854	4.19215	.25707	3.89004	.27576	3.62636	35
26	047	.53568	885	.18675	738	.88536	607	.62224	34
27	078	.52941	916	.18137	769	.88068	638	.61814	33
28	108	.52316	946	.17600	800	.87601	670	.61405	32
29	139	.51693	977	.17064	831	.87136	701	.60996	31
30	.22169	4.51071	.24008	4.16530	.25862	3.86671	.27732	3.60588	30
31	200	.50451	039	.15997	893	.86208	764	.60181	29
32	231	.49832	069	.15465	924	.85745	795	.59775	28
33	261	.49215	100	.14934	955	.85284	826	.59370	27
34	292	.48600	131	.14405	986	.84824	858	.58966	26
35	.22322	4.47986	.24162	4.13877	.26017	3.84364	.27889	3.58562	25
36	353	.47374	193	.13350	048	.83906	921	.58160	24
37	383	.46764	223	.12825	079	.83449	952	.57758	23
38	414	.46155	254	.12301	110	.82992	983	.57357	22
39	444	.45548	285	.11778	141	.82537	.28015	.56957	21
40	.22475	4.44942	.24316	4.11256	.26172	3.82083	.28046	3.56557	20
41	505	.44338	347	.10736	203	.81630	077	.56159	19
42	536	.43735	377	.10216	235	.81177	109	.55761	18
43	567	.43134	408	.09699	266	.80726	140	.55364	17
44	597	.42534	439	.09182	297	.80276	172	.54968	16
45	.22628	4.41936	.24470	4.08666	.26328	3.79827	.28203	3.54573	15
46	658	.41340	501	.08152	359	.79378	234	.54179	14
47	689	.40745	532	.07639	390	.78931	266	.53785	13
48	719	.40152	562	.07127	421	.78485	297	.53393	12
49	750	.39560	593	.06616	452	.78040	329	.53001	11
50	.22781	4.38969	.24624	4.06107	.26483	3.77595	.28360	3.52609	10
51	811	.38381	655	.05599	515	.77152	391	.52219	9
52	842	.37793	686	.05092	546	.76709	423	.51829	8
53	872	.37207	717	.04586	577	.76268	454	.51441	7
54	903	.36623	747	.04081	608	.75828	486	.51053	6
55	.22934	4.36040	.24778	4.03578	.26639	3.75388	.28517	3.50666	5
56	964	.35459	809	.03076	670	.74950	549	.50279	4
57	995	.34879	840	.02574	701	.74512	580	.49894	3
58	.23026	.34300	871	.02074	733	.74075	612	.49509	2
59	056	.33723	902	.01576	764	.73640	643	.49125	1
60	.23087	4.33148	.24933	4.01078	.26795	3.73205	.28675	3.48741	0
	77° Cot.	77° Tan.	76° Cot.	76° Tan.	75° Cot.	75° Tan.	74° Cot.	74° Tan.	M.

	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	
0	.28675	3.48741	.30573	3.27085	.32492	3.07768	.34433	2.90421	60
1	706	.48359	605	.26745	524	.07464	465	.90147	59
2	738	.47977	637	.26406	556	.07160	498	.89873	58
3	769	.47596	669	.26067	588	.06857	530	.89600	57
4	801	.47216	700	.25729	621	.06554	563	.89327	56
5	.28832	3.46837	.30732	3.25392	.32653	3.06252	.34596	2.89055	55
6	864	.46458	764	.25055	685	.05950	628	.88783	54
7	895	.46080	796	.24719	717	.05649	661	.88511	53
8	927	.45703	828	.24383	749	.05349	693	.88240	52
9	958	.45327	860	.24049	782	.05049	726	.87970	51
10	.28990	3.44951	.30891	3.23714	.32814	3.04749	.34758	2.87700	50
11	.29021	.44576	923	.23381	846	.04450	791	.87430	49
12	053	.44202	955	.23048	878	.04152	824	.87161	48
13	084	.43829	987	.22715	911	.03854	856	.86892	47
14	116	.43456	.31019	.22384	943	.03556	889	.86624	46
15	.29147	3.43084	.31051	3.22053	.32975	3.03260	.34922	2.86356	45
16	179	.42713	083	.21722	.33007	.02963	954	.86089	44
17	210	.42343	115	.21392	040	.02667	987	.85822	43
18	242	.41973	147	.21063	072	.02372	.35020	.85555	42
19	274	.41604	178	.20734	104	.02077	052	.85289	41
20	.29305	3.41236	.31210	3.20406	.33136	3.01783	.35085	2.85023	40
21	337	.40869	242	.20079	169	.01489	118	.84758	39
22	368	.40502	274	.19752	201	.01196	150	.84494	38
23	400	.40136	306	.19426	233	.00903	183	.84229	37
24	432	.39771	338	.19100	266	.00611	216	.83965	36
25	.29463	3.39406	.31370	3.18775	.33298	3.00319	.35248	2.83702	35
26	495	.39042	402	.18451	330	.00028	281	.83439	34
27	526	.38679	434	.18127	363	2.99738	314	.83176	33
28	558	.38317	466	.17804	395	.99447	346	.82914	32
29	590	.37955	498	.17481	427	.99158	379	.82653	31
30	.29621	3.37594	.31530	3.17159	.33460	2.98868	.35412	2.82391	30
31	653	.37234	562	.16838	492	.98580	445	.82130	29
32	685	.36875	594	.16517	524	.98292	477	.81870	28
33	716	.36516	626	.16197	557	.98004	510	.81610	27
34	748	.36158	658	.15877	589	.97717	543	.81350	26
35	.29780	3.35800	.31690	3.15558	.33621	2.97430	.35576	2.81091	25
36	811	.35443	722	.15240	654	.97144	608	.80833	24
37	843	.35087	754	.14922	686	.96858	641	.80574	23
38	875	.34732	786	.14605	718	.96573	674	.80316	22
39	906	.34377	818	.14288	751	.96288	707	.80059	21
40	.29938	3.34023	.31850	3.13972	.33783	2.96004	.35740	2.79802	20
41	970	.33670	882	.13656	816	.95721	772	.79545	19
42	.30001	.33317	914	.13341	848	.95437	805	.79289	18
43	033	.32965	946	.13027	881	.95155	838	.79033	17
44	065	.32614	978	.12713	913	.94872	871	.78778	16
45	.30097	3.32264	.32010	3.12400	.33945	2.94591	.35904	2.78523	15
46	128	.31914	042	.12087	978	.94309	937	.78269	14
47	160	.31565	074	.11775	.34010	.94028	969	.78014	13
48	192	.31216	106	.11464	043	.93748	.36002	.77761	12
49	224	.30868	139	.11153	075	.93468	035	.77507	11
50	.30255	3.30521	.32171	3.10842	.34108	2.93189	.36068	2.77254	10
51	287	.30174	203	.10532	140	.92910	101	.77002	9
52	319	.29829	235	.10223	173	.92632	134	.76750	8
53	351	.29483	267	.09914	205	.92354	167	.76498	7
54	382	.29139	299	.09606	238	.92076	199	.76247	6
55	.30414	3.28795	.32331	3.09298	.34270	2.91799	.36232	2.75996	5
56	446	.28452	363	.08991	303	.91523	265	.75746	4
57	478	.28109	396	.08685	335	.91246	298	.75496	3
58	509	.27767	428	.08379	368	.90971	331	.75246	2
59	541	.27426	460	.08073	400	.90696	364	.74997	1
60	.30573	3.27085	.32492	3.07768	.34433	2.90421	.36397	2.74748	0
	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	M.
	73°		72°		71°		70°		

M.	20° Tan.	20° Cot.	21° Tan.	21° Cot.	22° Tan.	22° Cot.	23° Tan.	23° Cot.	
0	.36397	2.74748	.38386	2.60509	.40403	2.47509	.42447	2.35585	60
1	430	.74499	420	.60283	436	.47302	482	.35395	59
2	463	.74251	453	.60057	470	.47095	516	.35205	58
3	496	.74004	487	.59831	504	.46888	551	.35015	57
4	529	.73756	520	.59606	538	.46682	585	.34825	56
5	.36562	2.73509	.38553	2.59381	.40572	2.46476	.42619	2.34636	55
6	595	.73263	587	.59156	606	.46270	654	.34447	54
7	628	.73017	620	.58932	640	.46065	688	.34258	53
8	661	.72771	654	.58708	674	.45860	722	.34069	52
9	694	.72526	687	.58484	707	.45655	757	.33881	51
10	.36727	2.72281	.38721	2.58261	.40741	2.45451	.42791	2.33693	50
11	760	.72036	754	.58038	775	.45246	826	.33505	49
12	793	.71792	787	.57815	809	.45043	860	.33317	48
13	826	.71548	821	.57593	843	.44839	894	.33130	47
14	859	.71305	854	.57371	877	.44636	929	.32943	46
15	.36892	2.71062	.38888	2.57150	.40911	2.44433	.42963	2.32756	45
16	925	.70819	921	.56928	945	.44230	998	.32570	44
17	958	.70577	955	.56707	979	.44027	.43032	.32383	43
18	991	.70335	988	.56487	.41013	.43825	067	.32197	42
19	.37024	.70094	.39022	.56266	047	.43623	101	.32012	41
20	.37057	2.69853	.39055	2.56046	.41081	2.43422	.43136	2.31826	40
21	090	.69612	089	.55827	115	.43220	170	.31641	39
22	123	.69371	122	.55608	149	.43019	205	.31456	38
23	157	.69131	156	.55389	183	.42819	239	.31271	37
24	190	.68892	190	.55170	217	.42618	274	.31086	36
25	.37223	2.68653	.39223	2.54952	.41251	2.42418	.43308	2.30902	35
26	256	.68414	257	.54734	285	.42218	343	.30718	34
27	289	.68175	290	.54516	319	.42019	378	.30534	33
28	322	.67937	324	.54299	353	.41819	412	.30351	32
29	355	.67700	357	.54082	387	.41620	447	.30167	31
30	.37388	2.67462	.39391	2.53865	.41421	2.41421	.43481	2.29984	30
31	422	.67225	425	.53648	455	.41223	516	.29801	29
32	455	.66989	458	.53432	490	.41025	550	.29619	28
33	488	.66752	492	.53217	524	.40827	585	.29437	27
34	521	.66516	526	.53001	558	.40629	620	.29254	26
35	.37554	2.66281	.39559	2.52786	.41592	2.40432	.43654	2.29073	25
36	588	.66046	593	.52571	626	.40235	689	.28891	24
37	621	.65811	626	.52357	660	.40038	724	.28710	23
38	654	.65576	660	.52142	694	.39841	758	.28528	22
39	687	.65342	694	.51929	728	.39645	793	.28348	21
40	.37720	2.65109	.39727	2.51715	.41763	2.39449	.43828	2.28167	20
41	754	.64875	761	.51502	797	.39253	862	.27987	19
42	787	.64642	795	.51289	831	.39058	897	.27806	18
43	820	.64410	829	.51076	865	.38863	932	.27626	17
44	853	.64177	862	.50864	899	.38668	966	.27447	16
45	.37887	2.63945	.39896	2.50652	.41933	2.38473	.44001	2.27267	15
46	920	.63714	930	.50440	968	.38279	036	.27088	14
47	953	.63483	963	.50229	.42002	.38084	071	.26909	13
48	986	.63252	997	.50018	036	.37891	105	.26730	12
49	.38020	.63021	.40031	.49807	070	.37697	140	.26552	11
50	.38053	2.62791	.40065	2.49597	.42105	2.37504	.44175	2.26374	10
51	086	.62561	098	.49386	139	.37311	210	.26196	9
52	120	.62332	132	.49177	173	.37118	244	.26018	8
53	153	.62103	166	.48967	207	.36925	279	.25840	7
54	186	.61874	200	.48758	242	.36733	314	.25663	6
55	.38220	2.61646	.40234	2.48549	.42276	2.36541	.44349	2.25486	5
56	253	.61418	267	.48340	310	.36349	384	.25309	4
57	286	.61190	301	.48132	345	.36158	418	.25132	3
58	320	.60963	335	.47924	379	.35967	453	.24956	2
59	353	.60736	369	.47716	413	.35776	488	.24780	1
60	.38386	2.60509	.40403	2.47509	.42447	2.35585	.44523	2.24604	0
	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	M.
	69°		68°		67°		66°		

M.	24° Tan.	24° Cot.	25° Tan.	25° Cot.	26° Tan.	26° Cot.	27° Tan.	27° Cot.	
0	.44523	2.24604	.46631	2.14451	.48773	2.05030	.50953	1.96261	60
1	558	.24428	666	.14288	809	.04879	989	.96120	59
2	593	.24252	702	.14125	845	.04728	.51026	.95979	58
3	627	.24077	737	.13963	881	.04577	063	.95838	57
4	662	.23902	772	.13801	917	.04426	099	.95698	56
5	.44697	2.23727	.46808	2.13639	.48953	2.04276	.51136	1.95557	55
6	732	.23553	843	.13477	989	.04125	173	.95417	54
7	767	.23378	879	.13316	.49026	.03975	209	.95277	53
8	802	.23204	914	.13154	062	.03825	246	.95137	52
9	837	.23030	950	.12993	098	.03675	283	.94997	51
10	.44872	2.22857	.46985	2.12832	.49134	2.03526	.51319	1.94858	50
11	907	.22683	.47021	.12671	170	.03376	356	.94718	49
12	942	.22510	056	.12511	206	.03227	393	.94579	48
13	977	.22337	092	.12350	242	.03078	430	.94440	47
14	.45012	.22164	128	.12190	278	.02929	467	.94301	46
15	.45047	2.21992	.47163	2.12030	.49315	2.02780	.51503	1.94162	45
16	082	.21819	199	.11871	351	.02631	540	.94023	44
17	117	.21647	234	.11711	387	.02483	577	.93885	43
18	152	.21475	270	.11552	423	.02335	614	.93746	42
19	187	.21304	305	.11392	459	.02187	651	.93608	41
20	.45222	2.21132	.47341	2.11233	.49495	2.02039	.51688	1.93470	40
21	257	20961	377	.11075	532	.01891	724	.93332	39
22	292	.20790	412	.10916	568	.01743	761	.93195	38
23	327	.20619	448	.10758	604	.01596	798	.93057	37
24	362	.20449	483	.10600	640	.01449	835	.92920	36
25	.45397	2.20278	.47519	2.10442	.49677	2.01302	.51872	1.92782	35
26	432	.20108	555	.10284	713	.01155	909	.92645	34
27	467	.19938	590	.10126	749	.01008	946	.92508	33
28	502	.19769	626	.09969	786	.00862	983	.92371	32
29	538	.19599	662	.09811	822	.00715	.52020	.92235	31
30	.45573	2.19430	.47698	2.09654	.49858	2.00569	.52057	1.92098	30
31	608	.19261	733	.09498	894	.00423	094	.91962	29
32	643	.19092	769	.09341	931	.00277	131	.91826	28
33	678	.18923	805	.09184	967	00131	168	.91690	27
34	713	.18755	840	.09028	.50004	1.99986	205	.91554	26
35	.45748	2.18587	.47876	2.08872	.50040	1 99841	.52242	1.91418	25
36	784	.18419	912	.08716	076	.99695	279	.91282	24
37	819	.18251	948	.08560	113	.99550	316	.91147	23
38	854	.18084	984	.08405	149	.99406	353	.91012	22
39	889	.17916	.48019	.08250	185	.99261	390	.90876	21
40	.45924	2.17749	.48055	2.08094	.50222	1.99116	.52427	1.90741	20
41	960	.17582	091	.07939	258	.98972	464	.90607	19
42	995	.17416	127	.07785	295	.98828	501	.90472	18
43	.46030	.17249	163	.07630	331	.98684	538	.90337	17
44	065	.17083	198	.07476	368	.98540	575	.90203	16
45	.46101	2.16917	.48234	2.07321	.50404	1.98396	.52613	1.90069	15
46	136	.16751	270	.07167	441	.98253	650	.89935	14
47	171	.16585	306	.07014	477	.98110	687	.89801	13
48	206	.16420	342	.06860	514	.97966	724	.89667	12
49	242	.16255	378	.06706	550	.97823	761	.89533	11
50	.46277	2.16090	.48414	2.06553	.50587	1.97681	.52798	1.89400	10
51	312	.15925	450	.06400	623	.97538	836	.89266	9
52	348	.15760	486	.06247	660	.97395	873	.89133	8
53	383	.15596	521	.06094	696	.97253	910	.89000	7
54	418	.15432	557	.05942	733	.97111	947	.88867	6
55	.46454	2.15268	.48593	2.05790	.50769	1.96969	.52985	1.88734	5
56	489	.15104	629	.05637	806	.96827	.53022	.88602	4
57	525	.14940	665	.05485	843	.96685	059	.88469	3
58	560	.14777	701	.05333	879	.96544	096	.88337	2
59	595	.14614	737	.05182	916	.96402	134	.88205	1
60	.46631	2.14451	.48773	2.05030	.50953	1.96261	.53171	1.88073	0

Cot.

M.	28° Tan.	28° Cot.	29° Tan.	29° Cot.	30° Tan.	30° Cot.	31° Tan.	31° Cot.	
0	.53171	1.88073	.55431	1.80405	.57735	1.73205	.60086	1.66428	60
1	208	.87941	469	.80281	774	.73089	126	.66318	59
2	246	.87809	507	.80158	813	.72973	165	.66209	58
3	283	.87677	545	.80034	851	.72857	205	.66099	57
4	320	.87546	583	.79911	890	.72741	245	.65990	56
5	.53358	1.87415	.55621	1.79788	.57929	1.72625	.60284	1.65881	55
6	395	.87283	659	.79665	968	.72509	324	.65772	54
7	432	.87152	697	.79542	.58007	.72393	364	.65663	53
8	470	.87021	736	.79419	046	.72278	403	.65554	52
9	507	.86891	774	.79296	085	.72163	443	.65445	51
10	.53545	1.86760	.55812	1.79174	.58124	1.72047	.60483	1.65337	50
11	582	.86630	850	.79051	162	.71932	522	.65228	49
12	620	.86499	888	.78929	201	.71817	562	.65120	48
13	657	.86369	926	.78807	240	.71702	602	.65011	47
14	694	.86239	964	.78685	279	.71588	642	.64903	46
15	.53732	1.86109	.56003	1.78563	.58318	1.71473	.60681	1.64795	45
16	769	.85979	041	.78441	357	.71358	721	.64687	44
17	807	.85850	079	.78319	396	.71244	761	.64579	43
18	844	.85720	117	.78198	435	.71129	801	.64471	42
19	882	.85591	156	.78077	474	.71015	841	.64363	41
20	.53920	1.85462	.56194	1.77955	.58513	1.70901	.60881	1.64256	40
21	957	.85333	232	.77834	552	.70787	921	.64148	39
22	995	.85204	270	.77713	591	.70673	960	.64041	38
23	.54032	.85075	309	.77592	631	.70560	.61000	.63934	37
24	070	.84946	347	.77471	670	.70446	040	.63826	36
25	.54107	1.84818	.56385	1 77351	.58709	1.70332	.61080	1.63719	35
26	145	.84689	424	.77230	748	.70219	120	.63612	34
27	183	.84561	462	.77110	787	.70106	160	.63505	33
28	220	.84433	501	.76990	826	.69992	200	.63398	32
29	258	.84305	539	.76869	865	.69879	240	.63292	31
30	.54296	1.84177	.56577	1.76749	.58905	1.69766	.61280	1.63185	30
31	333	.84049	616	.76629	944	.69653	320	.63079	29
32	371	.83922	654	.76510	983	.69541	360	.62972	28
33	409	.83794	693	.76390	.59022	69428	400	.62866	27
34	446	.83667	731	.76271	061	.69316	440	.62760	26
35	.54484	1.83540	.56769	1.76151	.59101	1.69203	.61480	1.62654	25
36	522	.83413	808	.76032	140	.69091	520	.62548	24
37	560	.83286	846	.75913	179	.68979	561	.62442	23
38	597	.83159	885	.75794	218	.68866	601	.62336	22
39	635	.83033	923	.75675	258	.68754	641	.62230	21
40	.54673	1.82906	.56962	1.75556	.59297	1.68643	.61681	1.62125	20
41	711	.82780	.57000	.75437	336	.68531	721	.62019	19
42	748	.82654	039	.75319	376	.68419	761	.61914	18
43	786	.82528	078	.75200	415	.68308	801	.61808	17
44	824	.82402	116	.75082	454	.68196	842	.61703	16
45	.54862	1.82276	.57155	1.74964	.59494	1.68085	.61882	1.61598	15
46	900	.82150	193	.74846	533	.67974	922	.61493	14
47	938	.82025	232	.74728	573	.67863	962	.61388	13
48	975	.81899	271	.74610	612	.67752	.62003	.61283	12
49	.55013	.81774	309	.74492	651	.67641	043	.61179	11
50	.55051	1.81649	.57348	1.74375	.59691	1.67530	.62083	1.61074	10
51	089	.81524	386	.74257	730	.67419	124	.60970	9
52	127	.81399	425	.74140	770	.67309	164	.60865	8
53	165	.81274	464	.74022	809	.67198	204	.60761	7
54	203	.81150	503	.73905	849	.67088	245	.60657	6
55	.55241	1.81025	.57541	1.73788	.59888	1.66978	.62285	1.60553	5
56	279	.80901	580	.73671	928	.66867	325	.60449	4
57	317	.80777	619	.73555	967	.66757	366	.60345	3
58	355	.80653	657	.73438	.60007	.66647	406	.60241	2
59	393	.80529	696	.73321	046	.66538	446	.60137	1
60	.55431	1.80405	.57735	1.73205	.60086	1 66428	.62487	1.60033	0

5	60
6	59
8	58
0	57
2	56
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4	10
9	9
4	8
9	7
5	6
0	5
6	4
1	3
7	2
2	1
8	0
	M.

M.	36°		37°		38°				
	Tan.	Cot.	Tan.	Cot.	Tan.				
0	.72654	1.37638	.75355	1.32704	.78129	1.27994	.80978	1.23490	60
1	699	.37554	401	.32624	175	.27917	.81027	.23416	59
2	743	.37470	447	.32544	222	.27841	075	.23343	58
3	788	.37386	492	.32464	269	.27764	123	.23270	57
4	832	.37302	538	.32384	316	.27688	171	.23196	56
5	.72877	1.37218	.75584	1.32304	.78363	1.27611	.81220	1.23123	55
6	921	.37134	629	.32224	410	.27535	268	.23050	54
7	966	.37050	675	.32144	457	.27458	316	.22977	53
8	.73010	.36967	721	.32064	504	.27382	364	.22904	52
9	055	.36883	767	.31984	551	.27306	413	.22831	51
10	.73100	1. 00	.75812	1.31904	.78598	1.27230	.81461	1.22758	50
11	144	. 16	858	.31825	645	.27153	510	.22685	49
12	189	. 33	904	.31745	692	.27077	558	.22612	48
13	234	. 49	950	.31666	739	.27001	606	.22539	47
14	278	. 66	996	.31586	786	.26925	655	.22467	46
15	.73323	1. 83	.76042	1.31507	.78834	1.26849	.81703	1.22394	45
16	368	. 00	088	.31427	881	.26774	752	.22321	44
17	413	. 17	134	.31348	928	.26698	800	.22249	43
18	457	. [illegible]	180	.31269	975	.26622	849	.22176	42
19	502	. 51	226	.31190	.79022	.26546	898	.22104	41
[illegible]	.73547	1.35968	.76272	1.31110	.79070	1.26471	.81946	1.22031	40
21	592	.35885	318	.31031	117	.26395	995	.21959	39
22	637	.35802	364	.30952	164	.26319	.82044	.21886	38
23	681	.35719	410	.30873	212	.26244	092	.21814	37
24	726	.35637	456	.30795	259	.26169	141	.21742	36
25	.73771	1.35554	.76502	1.30716	.79306	1.26093	.82190	1.21670	35
26	816	.35472	548	.30637	354	.26018	238	.21598	34
27	861	.35389	594	.30558	401	.25943	287	.21526	33
28	906	.35307	640	.30480	449	.25867	336	.21454	32
29	951	.35224	686	.30401	496	.25792	385	.21382	31
30	.73996	1.35142	.76733	1.30323	.79544	1.25717	.82434	1.21310	30
31	.74041	.35060	779	.30244	591	.25642	483	.21238	29
32	086	.34978	825	.30166	639	.25567	531	.21166	28
33	131	.34896	871	.30087	686	.25492	580	.21094	27
34	176	.34814	918	.30009	734	.25417	629	.21023	26
35	.74221	1.34732	.76964	1.29931	.79781	1.25343	.82678	1.20951	25
36	267	.34650	.77010	.29853	829	.25268	727	.20879	24
37	312	.34568	057	.29775	877	.25193	776	.20808	23
38	357	.34487	103	.29696	924	.25118	825	.20736	22
39	402	.34405	149	.29618	972	.25044	874	.20665	21
40	.74447	1.34323	.77196	1.29541	.80020	1.24969	.82923	1.20593	20
41	492	.34242	242	.29463	067	.24895	972	.20522	19
42	538	.34160	289	.29385	115	.24820	.83022	.20451	18
43	583	.34079	335	.29307	163	.24746	071	.20379	17
44	628	.33998	382	.29229	211	.24672	120	.20308	16
45	.74674	1.33916	.77428	1.29152	.80258	1.24597	.83169	1.20237	15
46	719	.33835	475	.29074	306	.24523	218	.20166	14
47	764	.33754	521	.28997	354	.24449	268	.20095	13
48	810	.33673	568	.28919	402	.24375	317	.20024	12
49	855	.33592	615	.28842	450	.24301	366	.19953	11
50	.74900	1.33511	.77661	1.28764	.80498	1.24227	.83415	1.19882	10
51	946	.33430	708	.28687	546	.24153	465	.19811	9
[illegible]	991	.33349	754	.28610	594	.24079	514	.19740	8
53	.75037	.33268	801	.28533	642	.24005	564	.19669	7
54	082	.33187	848	.28456	690	.23931	613	.19599	6
55	.75128	1.33107	.77895	1.28379	.80738	1.23858	.83662	1.19528	5
56	173	.33026	941	.28302	786	.23784	712	.19457	4
[illegible]	219	.32946	988	.28225	834	.23710	761	.19387	3
[illegible]	264	.32865	.78035	.28148	882	.23637	811	.19316	2
59	310	.32785	082	.28071	930	.23563	860	.19246	1
60	.75355	1.32704	.78129	1.27994	.80978	1.23490	.83910	1.19175	0

Co

M.	40° Tan.	40° Cot.	41° Tan.	41° Cot.	42° Tan.	42° Cot.	43° Tan.	43° Cot.	
0	.83910	1.19175	.86929	1.15037	.90040	1.11061	.93252	1.07237	60
1	960	.19105	980	.14969	093	.10996	306	.07174	59
2	.84009	.19035	.87031	.14902	146	.10931	360	.07112	58
3	059	.18964	082	.14834	199	.10867	415	.07049	57
4	108	.18894	133	.14767	251	.10802	469	.06987	56
5	.84158	1.18824	.87184	1.14699	.90304	1.10737	.93524	1.06925	55
6	208	.18754	236	.14632	357	.10672	578	.06862	54
7	258	.18684	287	.14565	410	.10607	633	.06800	53
8	307	.18614	338	.14498	463	.10543	688	.06738	52
9	357	.18544	389	.14430	516	.10478	742	.06676	51
10	.84407	1.18474	.87441	1.14363	.90569	1.10414	.93797	1.06613	50
11	457	.18404	492	.14296	621	.10349	852	.06551	49
12	507	.18334	543	.14229	674	.10285	906	.06489	48
13	556	.18264	595	.14162	727	.10220	961	.06427	47
14	606	.18194	646	.14095	781	.10156	.94016	.06365	46
15	.84656	1.18125	.87698	1.14028	.90834	1.10091	.94071	1.06303	45
16	706	.18055	749	.13961	887	.10027	125	.06241	44
17	756	.17986	801	.13894	940	.09963	180	.06179	43
18	806	.17916	852	.13828	993	.09899	235	.06117	42
19	856	.17846	904	.13761	.91046	.09834	290	.06056	41
20	.84906	1.17777	.87955	1.13694	.91099	1.09770	.94345	1.05994	40
21	956	.17708	.88007	.13627	153	.09706	400	.05932	39
22	.85006	.17638	059	.13561	206	.09642	455	.05870	38
23	057	.17569	110	.13494	259	.09578	510	.05809	37
24	107	.17500	162	.13428	313	.09514	565	.05747	36
25	.85157	1.17430	.88214	1.13361	.91366	1.09450	.94620	1.05685	35
26	207	.17361	265	.13295	419	.09386	676	.05624	34
27	257	.17292	317	.13228	473	.09322	731	.05562	33
28	308	.17223	369	.13162	526	.09258	786	.05501	32
29	358	.17154	421	.13096	580	.09195	841	.05439	31
30	.85408	1.17085	.88473	1.13029	.91633	1.09131	.94896	1.05378	30
31	458	.17016	524	.12963	687	.09067	952	.05317	29
32	509	.16947	576	.12897	740	.09003	.95007	.05255	28
33	559	.16878	628	.12831	794	.08940	062	.05194	27
34	609	.16809	680	.12765	847	.08876	118	.05133	26
35	.85660	1.16741	.88732	1.12699	.91901	1.08813	.95173	1.05072	25
36	710	.16672	784	.12633	955	.08749	229	.05010	24
37	761	.16603	836	.12567	.92008	.08686	284	.04949	23
38	811	.16535	888	.12501	062	.08622	340	.04888	22
39	862	.16466	940	.12435	116	.08559	395	.04827	21
40	.85912	1.16398	.88992	1.12369	.92170	1.08496	.95451	1.04766	20
41	963	.16329	.89045	.12303	224	.08432	506	.04705	19
42	.86014	.16261	097	.12238	277	.08369	562	.04644	18
43	064	.16192	149	.12172	331	.08306	618	.04583	17
44	115	.16124	201	.12106	385	.08243	673	.04522	16
45	.86166	1.16056	.89253	1.12041	.92439	1.08179	.95729	1.04461	15
46	216	.15987	306	.11975	493	.08116	785	.04401	14
47	267	.15919	358	.11909	547	.08053	841	.04340	13
48	318	.15851	410	.11844	601	.07990	897	.04279	12
49	368	.15783	463	.11778	655	.07927	952	.04218	11
50	.86419	1.15715	.89515	1.11713	.92709	1.07864	.96008	1.04158	10
51	470	.15647	567	.11648	763	.07801	064	.04097	9
52	521	.15579	620	.11582	817	.07738	120	.04036	8
53	572	.15511	672	.11517	872	.07676	176	.03976	7
54	623	.15443	725	.11452	926	.07613	232	.03915	6
55	.86674	1.15375	.89777	1.11387	.92980	1.07550	.96288	1.03855	5
56	725	.15308	830	.11321	.93034	.07487	344	.03794	4
57	776	.15240	883	.11256	088	.07425	400	.03734	3
58	827	.15172	935	.11191	143	.07362	457	.03674	2
59	878	.15104	988	.11126	197	.07299	513	.03613	1
60	.86929	1.15037	.90040	1.11061	.93252	1.07237	.96569	1.03553	0
	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	Cot.	Tan.	M.
	49°		48°		47°		46°		

TABLE XVIII.—NATURAL TANGENTS AND COTANGENTS.

M.	44° Tan.	44° Cot.		M.	44° Tan.	44° Cot.		M.	44° Tan.	44° Cot.	
0	.96569	1.03553	60	20	.97700	1.02355	40	40	.98843	1.01170	20
1	625	.03493	59	21	756	.02295	39	41	901	.01112	19
2	681	.03433	58	22	813	.02236	38	42	958	.01053	18
3	738	.03372	57	23	870	.02176	37	43	.99016	.00994	17
4	794	.03312	56	24	927	.02117	36	44	073	.00935	16
5	.96850	1.03252	55	25	.97984	1.02057	35	45	.99131	1.00876	15
6	907	.03192	54	26	.98041	.01998	34	46	189	.00818	14
7	963	.03132	53	27	098	.01939	33	47	247	.00759	13
8	.97020	.03072	52	28	155	.01879	32	48	304	.00701	12
9	076	.03012	51	29	213	.01820	31	49	362	.00642	11
10	.97133	1.02952	50	30	.98270	1.01761	30	50	.99420	1.00583	10
11	189	.02892	49	31	327	.01702	29	51	478	.00525	9
12	246	.02832	48	32	384	.01642	28	52	536	.00467	8
13	302	.02772	47	33	441	.01583	27	53	594	.00408	7
14	359	.02713	46	34	499	.01524	26	54	652	.00350	6
15	.97416	1.02653	45	35	.98556	1.01465	25	55	.99710	1.00291	5
16	472	.02593	44	36	613	.01406	24	56	768	.00233	4
17	529	.02533	43	37	671	.01347	23	57	826	.00175	3
18	586	.02474	42	38	728	.01288	22	58	884	.00116	2
19	643	.02414	41	39	786	.01229	21	59	942	.00058	1
20	.97700	1.02355	40	40	.98843	1.01170	20	60	1.00000	1.00000	0
	45° Cot.	45° Tan.	M.		45° Cot.	45° Tan.	M.		45° Cot.	45° Tan.	M.

M.	0° Vers.	0° Exsec.	1° Vers.	1° Exsec.	2° Vers.	2° Exsec.	3° Vers.	3° Exsec.	M.
0	.00000	.00000	.00015	.00015	.00061	.00061	.00137	.00137	0
1	000	000	016	016	062	062	139	139	1
2	000	000	016	016	063	063	140	140	2
3	000	000	017	017	064	064	142	142	3
4	000	000	017	017	065	065	143	143	4
5	.00000	.00000	.00018	.00018	.00066	.00066	.00145	.00145	5
6	000	000	018	018	067	067	146	147	6
7	000	000	019	019	068	068	148	148	7
8	000	000	020	020	069	069	149	150	8
9	000	000	020	020	070	070	151	151	9
10	.00000	.00000	.00021	.00021	.00071	.00072	.00153	.00153	10
11	001	001	021	021	073	073	154	155	11
12	001	001	022	022	074	074	156	156	12
13	001	001	023	023	075	075	158	158	13
14	001	001	023	023	076	076	159	159	14
15	.00001	.00001	.00024	.00024	.00077	.00077	.00161	.00161	15
16	001	001	024	024	078	078	162	163	16
17	001	001	025	025	079	079	164	164	17
18	001	001	026	026	081	081	166	166	18
19	002	002	026	026	082	082	167	168	19
20	.00002	.00002	.00027	.00027	.00083	.00083	.00169	.00169	20
21	002	002	028	028	084	084	171	171	21
22	002	002	028	028	085	085	173	173	22
23	002	002	029	029	087	087	174	175	23
24	002	002	030	030	088	088	176	176	24
25	.00003	.00003	.00031	.00031	.00089	.00089	.00178	.00178	25
26	003	003	031	031	090	090	179	180	26
27	003	003	032	032	091	091	181	182	27
28	003	003	033	033	093	093	183	183	28
29	004	004	034	034	094	094	185	185	29
30	.00004	.00004	.00034	.00034	.00095	.00095	.00187	.00187	30
31	004	004	035	035	096	097	188	189	31
32	004	004	036	036	098	098	190	190	32
33	005	005	037	037	099	099	192	192	33
34	005	005	037	037	100	100	194	194	34
35	.00005	.00005	.00038	.00038	.00102	.00102	.00196	.00196	35
36	005	005	039	039	103	103	197	198	36
37	006	006	040	040	104	104	199	200	37
38	006	006	041	041	106	106	201	201	38
39	006	006	041	041	107	107	203	203	39
40	.00007	.00007	.00042	.00042	.00108	.00108	.00205	.00205	40
41	007	007	043	043	110	110	207	207	41
42	007	007	044	044	111	111	208	209	42
43	008	008	045	045	112	113	210	211	43
44	008	008	046	046	114	114	212	213	44
45	.00009	.00009	.00047	.00047	.00115	.00115	.00214	.00215	45
46	009	009	048	048	117	117	216	216	46
47	009	009	048	048	118	118	218	218	47
48	010	010	049	049	119	120	220	220	48
49	010	010	050	050	121	121	222	222	49
50	.00011	.00011	.00051	.00051	.00122	.00122	.00224	.00224	50
51	011	011	052	052	124	124	226	226	51
52	011	011	053	053	125	125	228	228	52
53	012	012	054	054	127	127	230	230	53
54	012	012	055	055	128	128	232	232	54
55	.00013	.00013	.00056	.00056	.00130	.00130	.00234	.00234	55
56	013	013	057	057	131	131	236	236	56
57	014	014	058	058	133	133	238	238	57
58	014	014	059	059	134	134	240	240	58
59	015	015	060	060	136	136	242	242	59
60	.00015	.00015	.00061	.00061	.00137	.00137	.00244	.00244	60

M.	4° Vers.	4° Exsec.	5° Vers.	5° Exsec.	6° Vers.	6° Exsec.	7° Vers.	7° Exsec.	M.
0	.00244	.00244	.00381	.00382	.00548	.00551	.00745	.00751	0
1	246	246	383	385	551	554	749	755	1
2	248	248	386	387	554	557	752	58	2
3	250	250	388	390	557	560	756	62	3
4	252	252	391	392	560	563	760	65	4
5	.00254	.00254	.00393	.00395	.00563	.00566	.00763	69	5
6	256	257	396	397	566	569	767	73	6
7	258	259	398	400	569	573	770	76	7
8	260	261	401	403	572	576	774	80	8
9	262	263	404	405	576	579	778	84	9
10	.00264	.00265	.00406	.00408	.00579	.00582	.00781	.00787	10
11	266	267	409	411	582	585	785	791	11
12	269	269	412	413	585	588	789	795	12
13	271	271	414	416	588	592	792	799	13
14	273	274	417	419	591	595	796	802	14
15	.00275	.00276	.00420	.00421	.00594	.00598	.00800	.00806	15
16	277	278	422	424	598	601	803	810	16
17	279	280	425	427	601	604	807	813	17
18	281	282	428	429	604	608	811	817	18
19	284	284	430	432	607	611	814	821	19
20	.00286	.00287	.00433	.00435	.00610	.00614	.00818	.00825	20
21	288	289	436	438	614	617	822	828	21
22	290	291	438	440	617	621	825	832	22
23	292	293	441	443	620	624	829	836	23
24	295	296	444	446	623	627	833	840	24
25	.00297	.00298	.00447	.00449	.00626	.00630	.00837	.00844	25
26	299	300	449	451	630	634	840	848	26
27	301	302	452	454	633	637	844	851	27
28	304	305	455	457	636	640	848	855	28
29	306	307	458	460	640	644	852	859	29
30	.00308	.00309	.00460	.00463	.00643	.00647	.00856	.00863	30
31	311	312	463	465	646	650	859	867	31
32	313	314	466	468	649	654	863	871	32
33	315	316	469	471	653	657	867	875	33
34	317	318	472	474	656	660	871	878	34
35	.00320	.00321	.00474	.00477	.00659	.00664	.00875	.00882	35
36	322	323	477	480	663	667	878	886	36
37	324	326	480	482	666	671	882	890	37
38	327	328	483	485	669	674	886	894	38
39	329	330	486	488	673	677	890	898	39
40	.00332	.00333	.00489	.00491	.00676	.00681	.00894	.00902	40
41	334	335	492	494	680	684	898	906	41
42	336	337	494	497	683	688	902	910	42
43	339	340	497	500	686	691	906	914	43
44	341	342	500	503	690	695	909	918	44
45	.00343	.00345	.00503	.00506	.00693	.00698	.00913	.00922	45
46	346	347	506	509	697	701	917	926	46
47	348	349	509	512	700	705	921	930	47
48	351	352	512	515	703	708	925	934	48
49	353	354	515	518	707	712	929	938	49
50	.00356	.00357	.00518	.00521	.00710	.00715	.00933	.00942	50
51	358	359	521	524	714	719	937	946	51
52	361	362	524	527	717	722	941	950	52
53	363	364	527	530	721	726	945	954	53
54	365	367	530	533	724	730	949	958	54
55	.00368	.00369	.00533	.00536	.00728	.00733	.00953	.00962	55
56	370	372	536	539	731	737	957	966	56
57	373	374	539	542	735	740	961	970	57
58	375	377	542	545	738	744	965	975	58
59	378	379	545	548	742	747	969	979	59
60	.00381	.00382	.00548	.00551	.00745	.00751	.00973	.00983	60

M.	8° Vers.	8° Exsec.	9° Vers.	9° Exsec.	10° Vers.	10° Exsec.	11° Vers.	11° Exsec.	M.
0	.00973	.00983	.01231	.01247	.01519	.01543	.01837	.01872	0
1	977	987	236	251	524	548	843	877	1
2	981	991	240	256	529	553	848	883	2
3	985	995	245	261	534	558	854	889	3
4	989	999	249	265	539	564	860	895	4
5	.00994	.01004	.01254	.01270	.01545	.01569	.01865	.01901	5
6	998	008	259	275	550	574	871	906	6
7	.01002	012	263	279	555	579	876	912	7
8	006	016	268	284	560	585	882	918	8
9	010	020	272	289	565	590	888	924	9
10	.01014	.01024	.01277	.01294	.01570	.01595	.01893	.01930	10
11	018	029	282	298	575	601	899	936	11
12	022	033	286	303	580	606	904	941	12
13	027	037	291	308	586	611	910	947	13
14	031	041	296	313	591	616	916	953	14
15	.01035	.01046	.01300	.01317	.01596	.01622	.01921	.01959	15
16	039	050	305	322	601	627	927	965	16
17	043	054	310	327	606	633	933	971	17
18	047	059	314	332	611	638	939	977	18
19	052	063	319	337	617	643	944	983	19
20	.01056	.01067	.01324	.01342	.01622	.01649	.01950	.01989	20
21	060	071	329	346	627	654	956	995	21
22	064	076	333	351	632	659	961	.02001	22
23	069	080	338	356	638	665	967	007	23
24	073	084	343	361	643	670	973	013	24
25	.01077	.01089	.01348	.01366	.01648	.01676	.01979	.02019	25
26	081	093	352	371	653	681	984	025	26
27	086	097	357	376	659	687	990	031	27
28	090	102	362	381	664	692	996	037	28
29	094	106	367	386	669	698	.02002	043	29
30	.01098	.01111	.01371	.01391	.01675	.01703	.02008	.02049	30
31	103	115	376	395	680	709	013	055	31
32	107	119	381	400	685	714	019	061	32
33	111	124	386	405	690	720	025	067	33
34	116	128	391	410	696	725	031	073	34
35	.01120	.01133	.01396	.01415	.01701	.01731	.02037	.02079	35
36	124	137	400	420	706	736	042	085	36
37	129	142	405	425	712	742	048	091	37
38	133	146	410	430	717	747	054	097	38
39	137	151	415	435	723	753	060	103	39
40	.01142	.01155	.01420	.01440	.01728	.01758	.02066	.02110	40
41	146	160	425	445	733	764	072	116	41
42	151	164	430	450	739	769	078	122	42
43	155	169	435	455	744	775	084	128	43
44	159	173	439	460	750	781	090	134	44
45	.01164	.01178	.01444	.01466	.01755	.01786	.02095	.02140	45
46	168	182	449	471	760	792	101	146	46
47	173	187	454	476	766	798	107	153	47
48	177	191	459	481	771	803	113	159	48
49	182	196	464	486	777	809	119	165	49
50	.01186	.01200	.01469	.01491	.01782	.01815	.02125	.02171	50
51	191	205	474	496	788	820	131	178	51
52	195	209	479	501	793	826	137	184	52
53	200	214	484	506	799	832	143	190	53
54	204	219	489	512	804	837	149	196	54
55	.01209	.01223	.01494	.01517	.01810	.01843	.02155	.02203	55
56	213	228	499	522	815	849	161	209	56
57	218	233	504	527	821	854	167	215	57
58	222	237	509	532	826	860	173	221	58
59	227	242	514	537	832	866	179	228	59
60	.01231	.01247	.01519	.01543	.01837	.01872	.02185	.02234	60

0	.02185	.02234	.02563	.02630	.02970	.03061	.03407	.03528	0
1	191	240	570	637	977	069	415	536	1
2	197	247	576	644	985	076	422	544	2
3	203	253	583	651	992	084	430	552	3
4	209	259	589	658	999	091	438	560	4
5	.02216	.02266	.02596	.02665	.03006	.03099	.03445	.03568	5
6	222	272	602	672	013	106	453	576	6
7	228	279	609	679	020	114	460	584	7
8	234	285	616	686	027	121	468	592	8
9	240	291	622	693	034	129	476	601	9
10	.02246	.02298	.02629	.02700	.03041	.03137	.03483	.03609	10
11	252	304	635	707	048	144	491	617	11
12	258	311	642	714	055	152	498	625	12
13	265	317	649	721	063	159	506	633	13
14	271	323	655	728	070	167	514	642	14
15	.02277	.02330	.02662	.02735	.03077	.03175	.03521	.03650	15
16	283	336	669	742	084	182	529	658	16
17	289	343	675	749	091	190	537	666	17
18	295	349	682	756	098	197	544	674	18
19	302	356	689	763	106	205	552	683	19
20	.02308	.02362	.02696	.02770	.03113	.03213	.03560	.03691	20
21	314	369	702	777	120	220	567	699	21
22	320	375	709	784	127	228	575	708	22
23	327	382	716	791	134	236	583	716	23
24	333	388	722	799	142	244	590	724	24
25	.02339	.02395	.02729	.02806	.03149	.03251	.03598	.03732	25
26	345	402	736	813	156	259	606	741	26
27	352	408	743	820	163	267	614	749	27
28	358	415	749	827	171	275	621	758	28
29	364	421	756	834	178	282	629	766	29
30	.02370	.02428	.02763	.02842	.03185	.03290	.03637	.03774	30
31	377	435	770	849	193	298	645	783	31
32	383	441	777	856	200	306	653	791	32
33	389	448	783	863	207	313	660	799	33
34	396	454	790	870	214	321	668	808	34
35	.02402	.02461	.02797	.02878	.03222	.03329	.03676	.03816	35
36	408	468	804	885	229	337	684	825	36
37	415	474	811	892	236	345	692	833	37
38	421	481	818	899	244	353	699	842	38
39	427	488	824	907	251	360	707	850	39
40	.02434	.02494	.02831	.02914	.03258	.03368	.03715	.03858	40
41	440	501	838	921	266	376	723	867	41
42	447	508	845	928	273	384	731	875	42
43	453	515	852	936	281	392	739	884	43
44	459	521	859	943	288	400	747	892	44
45	.02466	.02528	.02866	.02950	.03295	.03408	.03754	.03901	45
46	472	535	873	958	303	416	762	909	46
47	479	542	880	965	310	424	770	918	47
48	485	548	887	972	318	432	778	927	48
49	492	555	894	980	325	439	786	935	49
50	.02498	.02562	.02900	.02987	.03333	.03447	.03794	.03944	50
51	504	569	907	994	340	455	802	952	51
52	511	576	914	.03002	347	463	810	961	52
53	517	582	921	009	355	471	818	969	53
54	524	589	928	017	362	479	826	978	54
55	.02530	.02596	.02935	.03024	.03370	.03487	.03834	.03987	55
56	537	603	942	032	377	495	842	995	56
57	543	610	949	039	385	503	850	.04004	57
58	550	617	956	046	392	511	858	013	58
59	556	624	963	054	400	520	866	021	59
60	.02563	.02630	.02970	.03061	.03407	.03528	.03874	.04030	60

M	16°								
	Vers.	Exsec.	Ve						
0	.03874	.04030	.04370	.04569	.04894	.05146	.05448	.05762	0
1	882	039	378	578	903	156	458	73	1
2	890	047	387	588	912	166	467	83	2
3	898	056	395	597	921	176	477	94	3
4	906	065	404	606	930	186	486	05	4
5	.03914	.04073	.04412	.04616	.04939	.05196	.05496	15	5
6	922	082	421	625	948	206	505	26	6
7	930	091	429	635	957	216	515	36	7
8	938	100	438	644	967	226	524	47	8
9	946	108	446	653	976	236	534	58	9
10	.03954	.04117	.04455	.04663	.04985	.05246	.05543	.05869	10
11	963	126	464	672	994	256	553	879	11
12	971	135	472	682	.05003	266	562	890	12
13	979	144	481	691	012	276	572	901	13
14	987	152	489	700	021	286	582	911	14
15	.03995	.04161	.04498	.04710	.05030	.05297	.05591	.05922	15
16	.04003	170	507	719	039	307	601	933	16
17	011	179	515	729	048	317	610	944	17
18	019	188	524	738	057	327	620	955	18
19	028	197	533	748	067	337	630	965	19
20	.04036	.04206	.04541	.04757	.05076	.05347	.05639	.05976	20
21	044	214	550	767	085	357	649	987	21
22	052	223	559	776	094	367	658	998	22
23	060	232	567	786	103	378	668	.06009	23
24	069	241	576	795	112	388	678	020	24
25	.04077	.04250	.04585	.04805	.05122	.05398	.05687	.06030	25
26	085	259	593	815	131	408	697	041	26
27	093	268	602	824	140	418	707	052	27
28	102	277	611	834	149	429	716	063	28
29	110	286	620	843	158	439	726	074	29
30	.04118	.04295	.04628	.04853	.05168	.05449	.05736	.06085	30
31	126	304	637	863	177	460	746	096	31
32	135	313	646	872	186	470	755	107	32
33	143	322	655	882	195	480	765	118	33
34	151	331	663	891	205	490	775	129	34
35	.04159	.04340	.04672	.04901	.05214	.05501	.05785	.06140	35
36	168	349	681	911	223	511	794	151	36
37	176	358	690	920	232	521	804	162	37
38	184	367	699	930	242	532	814	173	38
39	193	376	707	940	251	542	824	184	39
40	.04201	.04385	.04716	.04950	.05260	.05552	.05833	.06195	40
41	209	394	725	959	270	563	843	206	41
42	218	403	734	969	279	573	853	217	42
43	226	413	743	979	288	584	863	228	43
44	234	422	752	989	298	594	873	239	44
45	.04243	.04431	.04760	.04998	.05307	.05604	.05882	.06250	45
46	251	440	769	.05008	316	615	892	261	46
47	260	449	778	018	326	625	902	272	47
48	268	458	787	028	335	636	912	283	48
49	276	468	796	038	[illegible]	646	922	295	49
50	.04285	.04477	.04805	.05047	.05354	.05657	.05932	.06306	50
51	293	486	814	057	363	667	942	317	51
52	302	495	823	067	373	678	951	328	52
53	310	504	832	077	382	688	961	339	53
54	319	514	841	087	391	699	971	350	54
55	.04327	.04523	.04850	.05097	.05401	.05709	.05981	.06362	55
56	336	532	858	107	410	720	991	373	56
57	344	541	867	116	420	730	.06001	384	57
58	353	551	876	126	429	741	011	395	58
59	361	560	885	136	439	751	021	407	59
60	.04370	.04569	.04894	.05146	.05448	.05762	.06031	.06418	60

TABLE XIX.—NATURAL VERSED SINES AND EXTERNAL SECANTS.

M.	20°		21°		22°		23°		M.
	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	
0	.06031	.06418	.06642	.07114	.07282	.07853	.07950	.08636	0
1	041	429	652	126	293	866	961	649	1
2	051	440	663	138	303	879	972	663	2
3	061	452	673	150	314	892	984	676	3
4	071	463	684	162	325	904	995	690	4
5	.06081	.06474	.06694	.07174	.07336	.07917	.08006	.08703	5
6	091	486	705	186	347	930	018	717	6
7	101	497	715	199	358	943	029	730	7
8	111	508	726	211	369	955	041	744	8
9	121	520	736	223	380	968	052	757	9
10	.06131	.06531	.06747	.07235	.07391	.07981	.08064	.08771	10
11	141	542	757	247	402	994	075	784	11
12	151	554	768	259	413	.08006	086	798	12
13	161	565	778	271	424	019	098	811	13
14	171	577	789	283	435	032	109	825	14
15	.06181	.06588	.06799	.07295	.07446	.08045	.08121	.08839	15
16	191	600	810	307	457	058	132	852	16
17	201	611	820	320	468	071	144	866	17
18	211	622	831	332	479	084	155	880	18
19	221	634	841	344	490	097	167	893	19
20	.06231	.06645	.06852	.07356	.07501	.08109	.08178	.08907	20
21	241	657	863	368	512	122	190	920	21
22	252	668	873	380	523	135	201	934	22
23	262	680	884	393	534	148	213	948	23
24	272	691	894	405	545	161	225	962	24
25	.06282	.06703	.06905	.07417	.07556	.08174	.08236	.08975	25
26	292	715	916	429	568	187	248	989	26
27	302	726	926	442	579	200	259	.09003	27
28	312	738	937	454	590	213	271	017	28
29	323	749	948	466	601	226	282	030	29
30	.06333	.06761	.06958	.07479	.07612	.08239	.08294	.09044	30
31	343	773	969	491	623	252	306	058	31
32	353	784	980	503	634	265	317	072	32
33	363	796	990	516	645	278	329	086	33
34	374	807	.07001	528	657	291	340	099	34
35	.06384	.06819	.07012	.07540	.07668	.08305	.08352	.09113	35
36	394	831	022	553	679	318	364	127	36
37	404	842	033	565	690	331	375	141	37
38	415	854	044	578	701	344	387	155	38
39	425	866	055	590	713	357	399	169	39
40	.06435	.06878	.07065	.07602	.07724	.08370	.08410	.09183	40
41	445	889	076	615	735	383	422	197	41
42	456	901	087	627	746	397	434	211	42
43	466	913	098	640	757	410	445	224	43
44	476	925	108	652	769	423	457	238	44
45	.06486	.06936	.07119	.07665	.07780	.08436	.08469	.09252	45
46	497	948	130	677	791	449	481	266	46
47	507	960	141	690	802	463	492	280	47
48	517	972	151	702	814	476	504	294	48
49	528	984	162	715	825	489	516	308	49
50	.06538	.06995	.07173	.07727	.07836	.08503	.08528	.09323	50
51	548	.07007	184	740	848	516	539	337	51
52	559	019	195	752	859	529	551	351	52
53	569	031	206	765	870	542	563	365	53
54	580	043	216	778	881	556	575	379	54
55	.06590	.07055	.07227	.07790	.07893	.08569	.08586	.09393	55
56	600	067	238	803	904	582	598	407	56
57	611	079	249	816	915	596	610	421	57
58	621	091	260	828	927	609	622	435	58
59	632	103	271	841	938	623	634	449	59
60	.06642	.07114	.07282	.07853	.07950	.08636	.08645	.09464	60

									M.
0	.11705	.13257	.12538	.14335	.13397	.15470	.14283	.16663	0
1	719	275	552	354	412	489	298	684	1
2	733	292	566	372	427	509	313	704	2
3	746	310	580	391	441	528	328	725	3
4	760	327	594	409	456	548	343	745	4
5	.11774	.13345	.12609	.14428	.13470	.15567	.14358	.16766	5
6	787	362	623	446	485	587	373	786	6
7	801	380	637	465	499	606	388	806	7
8	815	398	651	483	514	626	403	827	8
9	828	415	665	502	529	645	418	848	9
10	.11842	.13433	.12679	.14521	.13543	.15665	.14433	.16868	10
11	856	451	694	539	558	684	449	889	11
12	870	468	708	558	573	704	464	909	12
13	883	486	722	576	587	724	479	930	13
14	897	504	736	595	602	743	494	950	14
15	.11911	.13521	.12750	.14614	.13616	.15763	.14509	.16971	15
16	925	539	765	632	631	782	524	992	16
17	938	557	779	651	646	802	539	.17012	17
18	952	575	793	670	660	822	554	033	18
19	966	593	807	689	675	841	569	054	19
20	.11980	.13610	.12822	.14707	.13690	.15861	.14584	.17075	20
21	994	628	836	726	705	881	599	095	21
22	.12007	646	850	745	719	901	615	116	22
23	021	664	864	764	734	920	630	137	23
24	035	682	879	783	749	940	645	158	24
25	.12049	.13700	.12893	.14801	.13763	.15960	.14660	.17178	25
26	063	718	907	820	778	980	675	199	26
27	077	735	921	839	793	.16000	690	220	27
28	091	753	936	858	808	019	706	241	28
29	104	771	950	877	822	039	721	262	29
30	.12118	.13789	.12964	.14896	.13837	.16059	.14736	.17283	30
31	132	807	979	914	852	079	751	304	31
32	146	825	993	933	867	099	766	325	32
33	160	843	.13007	952	881	119	782	346	33
34	174	861	022	971	896	139	797	367	34
35	.12188	.13879	.13036	.14990	.13911	.16159	.14812	.17388	35
36	202	897	051	.15009	926	179	827	409	36
37	216	915	065	028	941	199	843	430	[illegible]
38	230	934	079	047	955	219	858	451	38
39	244	952	094	066	970	239	873	472	39
40	.12257	.13970	.13108	.15085	.13985	.16259	.14888	.17493	40
41	271	988	122	105	.14000	279	904	514	41
42	285	.14006	137	124	015	299	919	535	42
43	299	024	151	143	030	319	934	556	[illegible]
44	313	042	166	162	044	339	949	577	44
45	.12327	.14061	.13180	.15181	.14059	.16359	.14965	.17598	45
46	341	079	195	200	074	380	980	620	46
47	355	097	209	219	089	400	995	641	47
48	369	115	223	239	104	420	.15011	662	48
49	383	134	238	258	119	440	026	683	49
50	.12397	.14152	.13252	.15277	.14134	.16460	.15041	.17704	50
51	411	170	267	296	149	481	057	726	51
52	425	188	281	315	164	501	072	747	52
53	439	207	296	335	179	521	087	768	53
54	454	225	310	354	194	541	103	790	54
55	.12468	.14243	.13325	.15373	.14208	.16562	.15118	.17811	55
56	482	262	339	393	223	582	134	832	56
57	496	280	354	412	238	602	149	854	57
58	510	299	368	431	253	623	164	875	58
59	524	317	383	451	268	643	180	896	59
60	.12538	.14335	.13397	.15470	.14283	.16663	.15195	.17918	60

M.	32° Vers.	32° Exsec.	33° Vers.	33° Exsec.	34° Vers.	34° Exsec.	35° Vers.	35° Exsec.	M.
0	.15195	.17918	.16133	.19236	.17096	.20622	.18085	.22077	0
1	211	939	149	259	113	645	101	102	1
2	226	961	165	281	129	669	118	127	2
3	241	982	181	304	145	693	135	152	3
4	257	.18004	196	327	161	717	152	177	4
5	.15272	.18025	.16212	.19349	.17178	.20740	.18168	.22202	5
6	288	047	228	372	194	764	185	227	6
7	303	068	244	394	210	788	202	252	7
8	319	090	260	417	227	812	218	277	8
9	334	111	276	440	243	836	235	302	9
10	.15350	.18133	.16292	.19463	.17259	.20859	.18252	.22327	10
11	365	155	308	485	276	883	269	352	11
12	381	176	324	508	292	907	286	377	12
13	396	198	340	531	308	931	302	402	13
14	412	220	355	553	325	955	319	428	14
15	.15427	.18241	.16371	.19576	.17341	.20979	.18336	.22453	15
16	443	263	387	599	357	.21003	353	478	16
17	458	285	403	622	374	027	369	503	17
18	474	307	419	645	390	051	386	528	18
19	489	328	435	668	407	075	403	554	19
20	.15505	.18350	.16451	.19691	.17423	.21099	.18420	.22579	20
21	520	372	467	713	439	123	437	604	21
22	536	394	483	736	456	147	454	629	22
23	552	416	499	759	472	171	470	655	23
24	567	437	515	782	489	195	487	680	24
25	.15583	.18459	.16531	.19805	.17505	.21220	.18504	.22706	25
26	598	481	547	828	522	244	521	731	26
27	614	503	563	851	538	268	538	756	27
28	630	525	579	874	554	292	555	782	28
29	645	547	595	897	571	316	572	807	29
30	.15661	.18569	.16611	.19920	.17587	.21341	.18588	.22833	30
31	676	591	627	944	604	365	605	858	31
32	692	613	644	967	620	389	622	884	32
33	708	635	660	990	637	414	639	909	33
34	723	657	676	.20013	653	438	656	935	34
35	.15739	.18679	.16692	.20036	.17670	.21462	.18673	.22960	35
36	755	701	708	059	686	487	690	986	36
37	770	723	724	083	703	511	707	.23012	37
38	786	745	740	106	719	535	724	037	38
39	802	767	756	129	736	560	741	063	39
40	.15818	.18790	.16772	.20152	.17752	.21584	.18758	.23089	40
41	833	812	788	176	769	609	775	114	41
42	849	834	805	199	786	633	792	140	42
43	865	856	821	222	802	658	809	166	43
44	880	878	837	246	819	682	826	192	44
45	.15896	.18901	.16853	.20269	.17835	.21707	.18843	.23217	45
46	912	923	869	292	852	731	860	243	46
47	928	945	885	316	868	756	877	269	47
48	943	967	902	339	885	781	894	295	48
49	959	990	918	363	902	805	911	321	49
50	.15975	.19012	.16934	.20386	.17918	.21830	.18928	.23347	50
51	991	034	950	410	935	855	945	373	51
52	.16006	057	966	433	952	879	962	398	52
53	022	079	983	457	968	904	979	424	53
54	038	102	999	480	985	929	996	450	54
55	.16054	.19124	.17015	.20504	.18001	.21953	.19013	.23476	55
56	070	146	031	527	018	978	030	502	56
57	085	169	047	551	035	.22003	047	529	57
58	101	191	064	575	051	028	064	555	58
59	117	214	080	598	068	053	081	581	59
60	.16133	.19236	.17096	.20622	.18085	.22077	.19098	.23607	60

TABLE XIX.—NATURAL VERSED SINES AND EXTERNAL SECANTS.

M.	36° Vers.	36° Exsec.	37° Vers.	37° Exsec.	38° Vers.	38° Exsec.	39° Vers.	39° Exsec.	M.
0	.19098	.23607	.20136	.25214	.21199	.26902	.22285	.28676	0
1	115	633	154	241	217	931	304	706	1
2	133	659	171	269	235	960	322	737	2
3	150	685	189	296	253	988	340	767	3
4	167	711	207	324	271	.27017	359	797	4
5	.19184	.23738	.20224	.25351	.21289	.27046	.22377	.28828	5
6	201	764	242	379	306	075	395	858	6
7	218	790	259	406	324	104	414	889	7
8	235	816	277	434	342	133	432	919	8
9	252	843	294	462	360	162	450	950	9
10	.19270	.23869	.20312	.25489	.21378	.27191	.22469	.28980	10
11	287	895	329	517	396	221	487	.29011	11
12	304	922	347	545	414	250	506	042	12
13	321	948	365	572	432	279	524	072	13
14	338	975	382	600	450	308	542	103	14
15	.19356	.24001	.20400	.25628	.21468	.27337	.22561	.29133	15
16	373	028	417	656	486	366	579	164	16
17	390	054	435	683	504	396	598	195	17
18	407	081	453	711	522	425	616	226	18
19	424	107	470	739	540	454	634	256	19
20	.19442	.24134	.20488	.25767	.21558	.27483	.22653	.29287	20
21	459	160	506	795	576	513	671	318	21
22	476	187	523	823	595	542	690	349	22
23	493	213	541	851	613	572	708	380	23
24	511	240	559	879	631	601	727	411	24
25	.19528	.24267	.20576	.25907	.21649	.27630	.22745	.29442	25
26	545	293	594	935	667	660	764	473	26
27	562	320	612	963	685	689	782	504	27
28	580	347	629	991	703	719	801	535	28
29	597	373	647	.26019	721	748	819	566	29
30	.19614	.24400	.20665	.26047	.21739	.27778	.22838	.29597	30
31	632	427	682	075	757	807	856	628	31
32	649	454	700	104	775	837	875	659	32
33	666	481	718	132	794	867	893	690	33
34	684	508	736	160	812	896	912	721	34
35	.19701	.24534	.20753	.26188	.21830	.27926	.22930	.29752	35
36	718	561	771	216	848	956	949	784	36
37	736	588	789	245	866	985	967	815	37
38	753	615	807	273	884	.28015	986	846	38
39	770	642	824	301	902	045	.23004	877	39
40	.19788	.24669	.20842	.26330	.21921	.28075	.23023	.29909	40
41	805	696	860	358	939	105	041	940	41
42	822	723	878	387	957	134	060	971	42
43	840	750	895	415	975	164	079	.30003	43
44	857	777	913	443	993	194	097	034	44
45	.19875	.24804	.20931	.26472	.22012	.28224	.23116	.30066	45
46	892	832	949	500	030	254	134	097	46
47	909	859	967	529	048	284	153	129	47
48	927	886	984	557	066	314	172	160	48
49	944	913	.21002	586	084	344	190	192	49
50	.19962	.24940	.21020	.26615	.22103	.28374	.23209	.30223	50
51	979	967	038	643	121	404	228	255	51
52	997	995	056	672	139	434	246	287	52
53	.20014	.25022	074	701	157	464	265	318	53
54	032	049	092	729	176	495	283	350	54
55	.20049	.25077	.21109	.26758	.22194	.28525	.23302	.30382	55
56	066	104	127	787	212	555	321	413	56
57	084	131	145	815	231	585	339	445	57
58	101	159	163	844	249	615	358	477	58
59	119	186	181	873	267	646	377	509	59
60	.20136	.25214	.21199	.26902	.22285	.28676	.23396	.30541	60

M.	40° Vers.	40° Exsec.	41° Vers.	41° Exsec.	42° Vers.	42° Exsec.	43° Vers.	43° Exsec.	M.
0	.23396	.30541	.24529	.32501	.25686	.34563	.26865	.36733	0
1	414	573	548	535	705	599	884	770	1
2	433	605	567	568	724	634	904	807	2
3	452	636	586	602	744	669	924	844	3
4	470	668	605	636	763	704	944	881	4
5	.23489	.30700	.24625	.32669	.25783	.34740	.26964	.36919	5
6	508	732	644	703	802	775	984	956	6
7	527	764	663	737	822	811	.27004	993	7
8	545	796	682	770	841	846	024	.37030	8
9	564	829	701	804	861	882	043	068	9
10	.23583	.30861	.24720	.32838	.25880	.34917	.27063	.37105	10
11	602	893	739	872	900	953	083	143	11
12	620	925	759	905	920	988	103	180	12
13	639	957	778	939	939	.35024	123	218	13
14	658	989	797	973	959	060	143	255	14
15	.23677	.31022	.24816	.33007	.25978	.35095	.27163	.37293	15
16	696	054	835	041	998	131	183	330	16
17	714	086	854	075	.26017	167	203	368	17
18	733	119	874	109	037	203	223	406	18
19	752	151	893	143	056	238	243	443	19
20	.23771	.31183	.24912	.33177	.26076	.35274	.27263	.37481	20
21	790	216	931	211	096	310	283	519	21
22	808	248	950	245	115	346	303	556	22
23	827	281	970	279	135	382	323	594	23
24	846	313	989	314	154	418	343	632	24
25	.23865	.31346	.25008	.33348	.26174	.35454	.27363	.37670	25
26	884	378	027	382	194	490	383	708	26
27	903	411	047	416	213	526	403	746	27
28	922	443	066	451	233	562	423	784	28
29	941	476	085	485	253	598	443	822	29
30	.23959	.31509	.25104	.33519	.26272	.35634	.27463	.37860	30
31	978	541	124	554	292	670	483	898	31
32	997	574	143	588	312	707	503	936	32
33	.24016	607	162	622	331	743	523	974	33
34	035	640	182	657	351	779	543	.38012	34
35	.24054	.31672	.25201	.33691	.26371	.35815	.27563	.38051	35
36	073	705	220	726	390	852	583	089	36
37	092	738	240	760	410	888	603	127	37
38	111	771	259	795	430	924	623	165	38
39	130	804	278	830	449	961	643	204	39
40	.24149	.31837	.25297	.33864	.26469	.35997	.27663	.38242	40
41	168	870	317	899	489	.36034	683	280	41
42	187	903	336	934	509	070	703	319	42
43	206	936	356	968	528	107	723	357	43
44	225	969	375	.34003	548	143	743	396	44
45	.24244	.32002	.25394	.34038	.26568	.36180	.27764	.38434	45
46	262	035	414	073	587	217	784	473	46
47	281	068	433	108	607	253	804	512	47
48	300	101	452	142	627	290	824	550	48
49	320	134	472	177	647	327	844	589	49
50	.24339	.32168	.25491	.34212	.26667	.36363	.27864	.38628	50
51	358	201	511	247	686	400	884	666	51
52	377	234	530	282	706	437	905	705	52
53	396	267	549	317	726	474	925	744	53
54	415	301	569	352	746	511	945	783	54
55	.24434	.32334	.25588	.34387	.26766	.36548	.27965	.38822	55
56	453	368	608	423	785	585	985	860	56
57	472	401	627	458	805	622	.28005	899	57
58	491	434	647	493	825	659	026	938	58
59	510	468	666	528	845	696	046	977	59
60	.24529	.32501	.25686	.34563	.26865	.36733	.28066	.39016	60

′	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	′
0	.28066	.39016	.29289	.41421	.30534	.43956	.31800	.46628	0
1	086	055	310	463	555	999	821	674	1
2	106	095	330	504	576	.44042	843	719	2
3	127	134	351	545	597	086	864	765	3
4	147	173	372	586	618	129	885	811	4
5	.28167	.39212	.29392	.41627	.30639	.44173	.31907	.46857	5
6	187	251	413	669	660	217	928	903	6
7	208	291	433	710	681	260	949	949	7
8	228	330	454	752	702	304	971	995	8
9	248	369	475	793	723	347	992	.47041	9
10	.28268	.39409	.29495	.41835	.30744	.44391	.32013	.47087	10
11	289	448	516	876	765	435	035	134	11
12	309	487	537	918	786	479	056	180	12
13	329	527	557	959	807	523	077	226	13
14	350	566	578	.42001	828	567	099	272	14
15	.28370	.39606	.29599	.42042	.30849	.44610	.32120	.47319	15
16	390	646	619	084	870	654	141	365	16
17	410	685	640	126	891	698	163	411	17
18	431	725	661	168	912	742	184	458	18
19	451	764	681	209	933	787	205	504	19
20	.28471	.39804	.29702	.42251	.30954	.44831	.32227	.47551	20
21	492	844	723	293	975	875	248	598	21
22	512	884	743	335	996	919	270	644	22
23	532	924	764	377	.31017	963	291	691	23
24	553	963	785	419	038	.45007	312	738	24
25	.28573	.40003	.29805	.42461	.31059	.45052	.32334	.47784	25
26	593	043	826	503	080	096	355	831	26
27	614	083	847	545	101	141	377	878	27
28	634	123	868	587	122	185	398	925	28
29	655	163	888	630	143	229	420	972	29
30	.28675	.40203	.29909	.42672	.31165	.45274	.32441	.48019	30
31	695	243	930	714	186	319	462	066	31
32	716	283	951	756	207	363	484	113	32
33	736	324	971	799	228	408	505	160	33
34	757	364	992	841	249	452	527	207	34
35	.28777	.40404	.30013	.42883	.31270	.45497	.32548	.48254	35
36	797	444	034	926	291	542	570	301	36
37	818	485	054	968	312	587	591	349	37
38	838	525	075	.43011	334	631	613	396	38
39	859	565	096	053	355	676	634	443	39
40	.28879	.40606	.30117	.43096	.31376	.45721	.32656	.48491	40
41	900	646	138	139	397	766	677	538	41
42	920	687	158	181	418	811	699	586	42
43	941	727	179	224	439	856	720	633	43
44	961	768	200	267	461	901	742	681	44
45	.28981	.40808	.30221	.43309	.31482	.45946	.32763	.48728	45
46	.29002	849	242	352	503	992	785	776	46
47	022	890	263	395	524	.46037	806	824	47
48	043	930	283	438	545	082	828	871	48
49	063	971	304	481	566	127	849	919	49
50	.29084	.41012	.30325	.43524	.31588	.46173	.32871	.48967	50
51	104	053	346	567	609	218	893	.49015	51
52	125	093	367	610	630	263	914	063	52
53	145	134	388	653	651	309	936	111	53
54	166	175	409	696	673	354	957	159	54
55	.29187	.41216	.30430	.43739	.31694	.46400	.32979	.49207	55
56	207	257	451	783	715	445	.33001	255	56
57	228	298	471	826	736	491	022	303	57
58	248	339	492	869	758	537	044	351	58
59	269	380	513	912	779	582	065	399	59
60	.29289	.41421	.30534	.43956	.31800	.46628	.33087	.49448	60

M.	48° Vers.	48° Exsec.	49° Vers.	49° Exsec.	50° Vers.	50° Exsec.	51° Vers.	51° Exsec.	M
0	.33087	.49448	.34394	.52425	.35721	.55572	.37068	.58902	0
1	109	496	416	476	744	626	091	959	1
2	130	544	438	527	766	680	113	.59016	2
3	152	593	460	579	788	734	136	073	3
4	173	641	482	630	810	789	158	130	4
5	.33195	.49690	.34504	.52681	.35833	.55843	.37181	.59188	5
6	217	738	526	732	855	897	204	245	6
7	238	787	548	784	877	951	226	302	7
8	260	835	570	835	900	.56005	249	360	8
9	282	884	592	886	922	060	272	418	9
10	.33303	.49933	.34614	.52938	.35944	.56114	.37294	.59475	10
11	325	981	636	989	967	169	317	533	11
12	347	.50030	658	.53041	989	223	340	590	12
13	368	079	680	092	.36011	278	362	648	13
14	390	128	702	144	034	332	385	706	14
15	.33412	.50177	.34724	.53196	.36056	.56387	.37408	.59764	15
16	434	226	746	247	078	442	430	822	16
17	455	275	768	299	101	497	453	880	17
18	477	324	790	351	123	551	476	938	18
19	499	373	812	403	146	606	498	996	19
20	.33520	.50422	.34834	.53455	.36168	.56661	.37521	.60054	20
21	542	471	856	507	190	716	544	112	21
22	564	521	878	559	213	771	567	171	22
23	586	570	900	611	235	826	589	229	23
24	607	619	923	663	258	881	612	287	24
25	.33629	.50669	.34945	.53715	.36280	.56937	.37635	.60346	25
26	651	718	967	768	302	992	658	404	26
27	673	767	989	820	325	.57047	680	463	27
28	694	817	.35011	872	347	103	703	521	28
29	716	866	033	924	370	158	726	580	29
30	.33738	.50916	.35055	.53977	.36392	.57213	.37749	.60639	30
31	760	966	077	.54029	415	269	771	698	31
32	782	.51015	099	082	437	324	794	756	32
33	803	065	122	134	460	380	817	815	33
34	825	115	144	187	482	436	840	874	34
35	.33847	.51165	.35166	.54240	.36504	.57491	.37862	.60933	35
36	869	215	188	292	527	547	885	992	36
37	891	265	210	345	549	603	908	.61051	37
38	912	314	232	398	572	659	931	111	38
39	934	364	254	451	594	715	954	170	39
40	.33956	.51415	.35277	.54504	.36617	.57771	.37976	.61229	40
41	978	465	299	557	639	827	999	288	41
42	.34000	515	321	610	662	883	.38022	348	42
43	022	565	343	663	684	939	045	407	43
44	044	615	365	716	707	995	068	467	44
45	.34065	.51665	.35388	.54769	.36729	.58051	.38091	.61526	45
46	087	716	410	822	752	108	113	586	46
47	109	766	432	876	775	164	136	646	47
48	131	817	454	929	797	221	159	705	48
49	153	867	476	982	820	277	182	765	49
50	.34175	.51918	.35499	.55036	.36842	.58333	.38205	25	50
51	197	968	521	089	865	390	228	85	51
52	219	.52019	543	143	887	447	251	45	52
53	241	069	565	196	910	503	274	05	53
54	262	120	588	250	932	560	296	65	54
55	.34284	.52171	.35610	.55303	.36955	.58617	.38319	25	55
56	306	222	632	357	978	674	342	85	56
57	328	273	654	411	.37000	731	365	46	57
58	350	323	677	465	023	788	388	06	58
59	372	374	699	518	045	845	411	66	59
60	.34394	.52425	.35721	.55572	.37068	.58902	.38434	27	60

M.	52°		53°		54°		55°		M.
	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	
0	.38434	.62427	.39818	.66164	.41221	.70130	.42642	.74345	0
1	457	487	842	228	245	198	666	417	1
2	480	548	865	292	269	267	690	490	2
3	503	609	888	357	292	335	714	562	3
4	526	669	911	421	316	403	738	635	4
5	.38549	.62730	.39935	.66486	.41339	.70472	.42762	.74708	5
6	571	791	958	550	363	540	785	781	6
7	594	852	981	615	386	609	809	854	7
8	617	913	.40005	679	410	677	833	927	8
9	640	974	028	744	433	746	857	.75000	9
10	.38663	.63035	.40051	.66809	.41457	.70815	.42881	.75073	10
11	686	096	074	873	481	884	905	146	11
12	709	157	098	938	504	953	929	219	12
13	732	218	121	.67003	528	.71022	953	293	13
14	755	279	144	068	551	091	976	366	14
15	.38778	.63341	.40168	.67133	.41575	.71160	.43000	.75440	15
16	801	402	191	198	599	229	024	513	16
17	824	464	214	264	622	298	048	587	17
18	847	525	237	329	646	368	072	661	18
19	870	587	261	394	670	437	096	734	19
20	.38893	.63648	.40284	.67460	.41693	.71506	.43120	.75808	20
21	916	710	307	525	717	576	144	882	21
22	939	772	331	591	740	646	168	956	22
23	962	834	354	656	764	715	192	.76031	23
24	985	895	378	722	788	785	216	105	24
25	.39009	.63957	.40401	.67788	.41811	.71855	.43240	.76179	25
26	032	.64019	424	853	835	925	264	253	26
27	055	081	448	919	859	995	287	328	27
28	078	144	471	985	882	.72065	311	402	28
29	101	206	494	.68051	906	135	335	477	29
30	.39124	.64268	.40518	.68117	.41930	.72205	.43359	.76552	30
31	147	330	541	183	953	275	383	626	31
32	170	393	564	250	977	346	407	701	32
33	193	455	588	316	.42001	416	431	776	33
34	216	518	611	382	024	487	455	851	34
35	.39239	.64580	.40635	.68449	.42048	.72557	.43479	.76926	35
36	262	643	658	515	072	628	503	.77001	36
37	286	705	682	582	096	698	527	077	37
38	309	768	705	648	119	769	551	152	38
39	332	831	728	715	143	840	575	227	39
40	.39355	.64894	.40752	.68782	.42167	.72911	.43599	.77303	40
41	378	957	775	848	190	982	623	378	41
42	401	.65020	799	915	214	.73053	647	454	42
43	424	083	822	982	238	124	671	530	43
44	447	146	846	.69049	262	195	695	606	44
45	.39471	.65209	.40869	.69116	.42285	.73267	.43720	.77681	45
46	494	272	892	183	309	338	744	757	46
47	517	335	916	250	333	409	768	833	47
48	540	399	939	318	357	481	792	910	48
49	563	462	963	385	381	552	816	986	49
50	.39586	.65526	.40986	.69452	.42404	.73624	.43840	.78062	50
51	610	589	.41010	520	428	696	864	138	51
52	633	653	033	587	452	768	888	215	52
53	656	717	057	655	476	840	912	291	53
54	679	780	080	723	499	911	936	368	54
55	.39702	.65844	.41104	.69790	.42523	.73983	.43960	.78445	55
56	726	908	127	858	547	.74056	984	521	56
57	749	972	151	926	571	128	.44008	598	57
58	772	.66036	174	994	595	200	032	675	58
59	795	100	198	.70062	619	272	057	752	59
60	.39818	.66164	.41221	.70130	.42642	.74345	.44081	.78829	60

M.	56° Vers.	56° Exsec.	57° Vers.	57° Exsec.	58° Vers.	58° Exsec.	59° Vers.	59° Exsec.	M.
0	.44081	.78829	.45536	.83608	.47008	.88708	.48496	.94160	0
1	105	906	560	690	033	796	521	254	1
2	129	984	585	773	057	884	546	349	2
3	153	.79061	609	855	082	972	571	443	3
4	177	138	634	938	107	.89060	596	537	4
5	.44201	.79216	.45658	.84020	.47131	.89148	.48621	.94632	5
6	225	293	683	103	156	237	646	726	6
7	250	371	707	186	181	325	671	821	7
8	274	449	731	269	206	414	696	916	8
9	298	527	756	352	230	503	721	.95011	9
10	.44322	.79604	.45780	.84435	.47255	.89591	.48746	.95106	10
11	346	682	805	518	280	680	771	201	11
12	370	761	829	601	304	769	796	296	12
13	395	839	854	685	329	858	821	392	13
14	419	917	878	768	354	948	846	487	14
15	44443	.79995	.45903	.84852	.47379	.90037	.48871	583	15
16	467	.80074	927	935	403	126	896	678	16
17	491	152	951	.85019	428	216	921	774	17
18	516	231	976	103	453	305	946	870	18
19	540	309	.46000	187	478	395	971	966	19
20	.44564	.80388	.46025	.85271	.47502	.90485	.48996	.96062	20
21	588	467	049	355	527	575	.49021	158	21
22	612	546	074	439	552	665	046	255	22
23	637	625	098	523	577	755	071	351	23
24	661	704	123	608	601	845	096	448	24
25	.44685	.80783	.46147	.85692	.47626	.90935	.49121	.96544	25
26	709	862	172	777	651	.91026	146	641	26
27	734	942	196	861	676	116	171	738	27
28	758	.81021	221	946	701	207	196	835	28
29	782	101	246	.86031	725	297	221	932	29
30	.44806	.81180	.46270	.86116	.47750	.91388	.49246	.97029	30
31	831	260	295	201	775	479	271	127	31
32	855	340	319	286	800	570	296	224	32
33	879	419	344	371	825	661	321	322	33
34	903	499	368	457	849	752	346	420	34
35	.44928	.81579	.46393	.86542	.47874	.91844	.49372	.97517	35
36	952	659	417	627	899	935	397	615	36
37	976	740	442	713	924	.92027	422	713	37
38	.45001	820	466	799	949	118	447	811	38
39	025	900	491	885	974	210	472	910	39
40	.45049	.81981	.46516	.86970	.47998	.92302	.49497	.98008	40
41	073	.82061	540	.87056	.48023	394	522	107	41
42	098	142	565	142	048	486	547	205	42
43	122	222	589	229	073	578	572	304	43
44	146	303	614	315	098	670	597	403	44
45	.45171	.82384	.46639	.87401	.48123	.92762	.49623	.98502	45
46	195	465	663	488	148	855	648	601	46
47	219	546	688	574	172	947	673	700	47
48	244	627	712	661	197	.93040	698	799	48
49	268	709	737	748	222	133	723	899	49
50	.45292	.82790	.46762	.87834	.48247	.93226	.49748	.98998	50
51	317	871	786	921	272	319	773	.99098	51
52	341	953	811	.88008	297	412	799	198	52
53	365	.83034	836	095	322	505	824	298	53
54	390	116	860	183	347	598	849	398	54
55	.45414	.83198	.46885	.88270	.48372	.93692	.49874	.99498	55
56	439	280	909	357	396	785	899	598	56
57	463	362	934	445	421	879	924	698	57
58	487	444	959	532	446	973	950	799	58
59	512	526	983	620	471	.94066	975	899	59
60	.45536	.83608	.47008	.88708	.48496	.94160	.50000	1.00000	60

M.	6 Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	M.
0	.50000	1.00000	.51519	1.06267	.53053	1.13005	.54601	1.20269	0
1	025	.00101	544	.06375	079	.13122	627	.20395	1
2	050	.00202	570	.06483	104	.13239	653	.20521	2
3	076	.00303	595	.06592	130	.13356	679	.20647	3
4	101	.00404	621	.06701	156	.13473	705	.20773	4
5	.50126	1.00505	.51646	1.06809	.53181	1.13590	.54731	1.20900	5
6	151	.00607	672	.06918	207	.13707	757	.21026	6
7	176	.00708	697	.07027	233	.13825	782	.21153	7
8	202	.00810	723	.07137	258	.13942	808	.21280	8
9	227	.00912	748	.07246	284	.14060	834	.21407	9
10	.50252	1.01014	.51774	1.07356	.53310	1.14178	.54860	1.21535	10
11	277	.01116	799	.07465	336	.14296	886	.21662	11
12	303	.01218	825	.07575	361	.14414	912	.21790	12
13	328	.01320	850	.07685	387	.14533	938	.21918	13
14	353	.01422	876	.07795	413	.14651	964	.22045	14
15	.50378	1.01525	.51901	1.07905	.53439	1.14770	.54990	1.22174	15
16	404	.01628	927	.08015	464	.14889	.55016	.22302	16
17	429	.01730	952	.08126	490	.15008	042	.22430	17
18	454	.01833	978	.08236	516	.15127	068	.22559	18
19	479	.01936	.52003	.08347	542	.15246	094	.22688	19
20	.50505	1.02039	.52029	1.08458	.53567	1.15366	.55120	1.22817	20
21	530	.02143	054	.08569	593	.15485	146	.22946	21
22	555	.02246	080	.08680	619	.15605	172	.23075	22
23	581	.02349	105	.08791	645	.15725	198	.23205	23
24	606	.02453	131	.08903	670	.15845	224	.23334	24
25	.50631	1.02557	.52156	1.09014	.53696	1.15965	.55250	1.23464	25
26	656	.02661	182	.09126	722	.16085	276	.23594	26
27	682	.02765	207	.09238	748	.16206	302	.23724	27
28	707	.02869	233	.09350	774	.16326	328	.23855	28
29	732	.02973	259	.09462	799	.16447	354	.23985	29
30	.50758	1.03077	.52284	1.09574	.53825	1.16568	.55380	1.24116	30
31	783	.03182	310	.09686	851	.16689	406	.24247	31
32	808	.03286	335	.09799	877	.16810	432	.24378	32
33	834	.03391	361	.09911	903	.16932	458	.24509	33
34	859	.03496	386	.10024	928	.17053	484	.24640	34
35	.50884	1.03601	.52412	1.10137	.53954	1.17175	.55510	1.24772	35
36	910	.03706	438	.10250	980	.17297	536	.24903	36
37	935	.03811	463	.10363	.54006	.17419	563	.25035	37
38	960	.03916	489	.10477	032	.17541	589	.25167	38
39	986	.04022	514	.10590	058	.17663	615	.25300	39
40	.51011	1.04128	.52540	1.10704	.54083	1.17786	.55641	1. [illegible]32	40
41	036	.04233	566	.10817	109	.17909	667	. [illegible]65	41
42	062	.04339	591	.10931	135	.18031	693	. [illegible]97	42
43	087	.04445	617	.11045	161	.18154	719	. [illegible]30	43
44	112	.04551	642	.11159	187	.18277	745	. [illegible]63	44
45	.51138	1.04657	.52668	1.11274	.54213	1.18401	55771	1. [illegible]97	45
46	163	.04764	694	.11388	238	.18524	797	. [illegible]30	46
47	189	.04870	719	.11503	264	.18648	823	. [illegible]64	47
48	214	.04977	745	.11617	290	.18772	849	. [illegible]98	48
49	239	.05084	771	.11732	316	.18895	876	. [illegible]32	49
50	.51265	1.05191	.52796	1.11847	.54342	1.19019	.55902	1.26766	50
51	290	.05298	822	.11963	368	.19144	928	.26900	51
52	316	.05405	847	.12078	394	.19268	954	.27035	52
53	341	.05512	873	.12193	420	.19393	980	.27169	53
54	366	.05619	899	.12309	446	.19517	.56006	.27304	54
55	.51392	1.05727	.52924	1.12425	.54471	1.19642	.56032	1.27439	55
56	417	.05835	950	.12540	497	.19767	058	.27574	56
57	443	.05942	976	.12657	523	.19892	084	.27710	57
58	468	.06050	.53001	.12773	549	.20018	111	.27845	58
59	494	.06158	027	.12889	575	.20143	137	.27981	59
60	.51519	1.06267	.53053	1.13005	.54601	1.20269	.56163	1.28117	60

M.	64° Vers.	64° Exsec.	65° Vers.	65° Exsec.	66° Vers.	66° Exsec.	67° Vers.	67° Exsec.	M.
0	.56163	1.28117	.57738	1.36620	.59326	1.45859	.60927	1.55930	0
1	189	.28253	765	.36768	353	.46020	954	.56106	1
2	215	.28390	791	.36916	379	.46181	980	.56282	2
3	241	.28526	817	.37064	406	.46342	.61007	.56458	3
4	267	.28663	844	.37212	433	.46504	034	.56634	4
5	.56294	1.28800	.57870	1.37361	.59459	1.46665	.61061	1.56811	5
6	320	.28937	896	.37509	486	.46827	088	.56988	6
7	346	.29074	923	.37658	512	.46989	114	.57165	7
8	372	.29211	949	.37808	539	.47152	141	.57342	8
9	398	.29349	976	.37957	566	.47314	168	.57520	9
10	.56425	1.29487	.58002	1.38107	.59592	1.47477	.61195	1.57698	10
11	451	.29625	028	.38256	619	.47640	222	.57876	11
12	477	.29763	055	.38406	645	.47804	248	.58054	12
13	503	.29901	081	.38556	672	.47967	275	.58233	13
14	529	.30040	108	.38707	699	.48131	302	.58412	14
15	.56555	1.30179	.58134	1 38857	.59725	1.48295	.61329	1.58591	15
16	582	.30318	160	.39008	752	.48459	356	.58771	16
17	608	.30457	187	.39159	779	.48624	383	.58950	17
18	634	.30596	213	.39311	805	.48789	409	.59130	18
19	660	.30735	240	.39462	832	.48954	436	.59311	19
20	.56687	1.30875	.58266	1.39614	.59859	1.49119	.61463	1.59491	20
21	713	.31015	293	.39766	885	.49284	490	.59672	21
22	739	.31155	319	.39918	912	.49450	517	.59853	22
23	765	.31295	345	.40070	938	.49616	544	.60035	23
24	791	.31436	372	.40222	965	.49782	570	.60217	24
25	.56818	1.31576	.58398	1 40375	.59992	1.49948	.61597	1.60399	25
26	844	.31717	425	.40528	.60018	.50115	624	.60581	26
27	870	.31858	451	.40681	045	.50282	651	.60763	27
28	896	.31999	478	.40835	072	.50449	678	.60946	28
29	923	.32140	504	.40988	098	.50617	705	.61129	29
30	.56949	1.32282	.58531	1.41142	.60125	1.50784	.61732	1.61313	30
31	975	.32424	557	.41296	152	.50952	759	.61496	31
32	.57001	.32566	584	.41450	178	.51120	785	.61680	32
33	028	.32708	610	.41605	205	.51289	812	.61864	33
34	054	.32850	637	.41760	232	51457	839	.62049	34
35	.57080	1.32993	.58663	1.41914	.60259	1.51626	.61866	1.62234	35
36	106	.33135	690	.42070	285	.51795	893	.62419	36
37	133	.33278	716	.42225	312	.51965	920	.62604	37
38	159	.33422	743	.42380	339	.52134	947	.62790	38
39	185	.33565	769	.42536	365	.52304	974	.62976	39
40	.57212	1.33708	.58796	1.42692	.60392	1.52474	.62001	1.63162	40
41	238	.33852	822	.42848	419	.52645	027	.63348	41
42	264	.33996	849	.43005	445	.52815	054	.63535	42
43	291	.34140	875	.43162	472	.52986	081	.63722	43
44	317	.34284	902	.43318	499	.53157	108	.63909	44
45	.57343	1.34429	.58928	1.43476	.60526	1.53329	.62135	1.64097	45
46	369	.34573	955	.43633	552	.53500	162	.64285	46
47	396	.34718	981	.43790	579	.53672	189	.64473	47
48	422	.34863	.59008	.43948	606	.53845	216	.64662	48
49	448	.35009	034	.44106	633	.54017	243	.64851	49
50	.57475	1.35154	.59061	1.44264	.60659	1.54190	.62270	1.65040	50
51	501	.35300	087	.44423	686	.54363	297	.65229	51
52	527	.35446	114	.44582	713	.54536	324	.65419	52
53	554	.35592	140	.44741	740	.54709	351	.65609	53
54	580	.35738	167	.44900	766	.54883	378	.65799	54
55	.57606	1.35885	.59194	1.45059	.60793	1.55057	.62405	1.65989	55
56	633	.36031	220	.45219	820	.55231	431	.66180	56
57	659	.36178	247	.45378	847	.55405	458	.66371	57
58	685	.36325	273	.45539	873	.55580	485	.66563	58
59	712	36473	300	.45699	900	.55755	512	.66755	59
60	.57738	1.36620	.59326	1.45859	.60927	1.55930	.62539	1.66947	60

M.	68° Vers.	68° Exsec.	69° Vers.	69° Exsec.	70° Vers.	70° Exsec.	71° Vers.	71° Exsec.	M.
0	.62539	1.66947	.64163	1.79043	.65798	1.92380	.67443	2.07155	0
1	566	.67139	190	.79254	825	.92614	471	.07415	1
2	593	.67332	218	.79466	853	.92849	498	.07675	2
3	620	.67525	245	.79679	880	.93083	526	.07936	3
4	647	.67718	272	.79891	907	.93318	553	.08197	4
5	.62674	1.67911	.64299	1.80104	.65935	1.93554	.67581	2.08459	5
6	701	.68105	326	.80318	962	.93790	608	.08721	6
7	728	.68299	353	.80531	989	.94026	636	.08983	7
8	755	.68494	381	.80746	.66017	.94263	663	.09246	8
9	782	.68689	408	.80960	044	.94500	691	.09510	9
10	.62809	1.68884	.64435	1.81175	.66071	1.94737	.67718	2.09774	10
11	836	.69079	462	.81390	099	.94975	746	.10038	11
12	863	.69275	489	.81605	126	.95213	773	.10303	12
13	890	.69471	516	.81821	154	.95452	801	.10568	13
14	917	.69667	544	.82037	181	.95691	829	.10834	14
15	.62944	1.69864	.64571	1.82254	.66208	1.95931	.67856	2.11101	15
16	971	.70061	598	.82471	236	.96171	884	.11367	16
17	998	.70258	625	.82688	263	.96411	911	.11635	17
18	.63025	.70455	653	.82906	290	.96652	939	.11903	18
19	052	.70653	680	.83124	318	.96893	966	.12171	19
20	.63079	1.70851	.64707	1.83342	.66345	1.97135	.67994	2.12440	20
21	106	.71050	734	.83561	373	.97377	.68021	.12709	21
22	133	.71249	761	.83780	400	.97619	049	.12979	22
23	161	.71448	789	.83999	427	.97862	077	.13249	23
24	188	.71647	816	.84219	455	.98106	104	.13520	24
25	.63215	1.71847	.64843	1.84439	.66482	1.98349	.68132	2.13791	25
26	242	.72047	870	.84659	510	.98594	159	.14063	26
27	269	.72247	898	.84880	537	.98838	187	.14335	27
28	296	.72448	925	.85102	564	.99083	214	.14608	28
29	323	.72649	952	.85323	592	.99329	242	.14881	29
30	.63350	1.72850	.64979	1.85545	.66619	1.99574	.68270	2.15155	30
31	377	.73052	.65007	.85767	647	.99821	297	.15429	31
32	404	.73254	034	.85990	674	2.00067	325	.15704	32
33	431	.73456	061	.86213	702	.00315	352	.15979	33
34	458	.73659	088	.86437	729	.00562	380	.16255	34
35	.63485	1.73862	.65116	1.86661	.66756	2.00810	.68407	2.16531	35
36	512	.74065	143	.86885	784	.01059	435	.16808	36
37	539	.74269	170	.87109	811	.01308	463	.17085	37
38	566	.74473	197	.87334	839	.01557	490	.17363	38
39	594	.74677	225	.87560	866	.01807	518	.17641	39
40	.63621	1.74881	.65252	1.87785	.66894	2.02057	.68546	2.17920	40
41	648	.75086	279	.88011	921	.02308	573	.18199	41
42	675	.75292	306	.88238	949	.02559	601	.18479	42
43	702	.75497	334	.88465	976	.02810	628	.18759	43
44	729	.75703	361	.88692	.67003	.03062	656	.19040	44
45	.63756	1.75909	.65388	1.88920	.67031	2.03315	.68684	2.19322	45
46	783	.76116	416	.89148	058	.03568	711	.19604	46
47	810	.76323	443	.89376	086	.03821	739	.19886	47
48	838	.76530	470	.89605	113	.04075	767	.20169	48
49	865	.76737	497	.89834	141	.04329	794	.20453	49
50	.63892	1.76945	.65525	1.90063	.67168	2.04584	.68822	2.20737	50
51	919	.77154	552	.90293	196	.04839	849	.21021	51
52	946	.77362	579	.90524	223	.05094	877	.21306	52
53	973	.77571	607	.90754	251	.05350	905	.21592	53
54	.64000	.77780	634	.90986	278	.05607	932	.21878	54
55	.64027	1.77990	.65661	1.91217	.67306	2.05864	.68960	2.22165	55
56	055	.78200	689	.91449	333	.06121	988	.22452	56
57	082	.78410	716	.91681	361	.06379	.69015	.22740	57
58	109	.78621	743	.91914	388	.06637	043	.23028	58
59	136	.78832	771	.92147	416	.06896	071	.23317	59
60	.64163	1.79043	.65798	1.92380	.67443	2.07155	.69098	2.23607	60

	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	
0	.69098	2.23607	.70763	2.42030	.72436	2.62796	.74118	2.86370	0
1	126	.23897	791	.42356	464	.63164	146	.86790	1
2	154	.24187	818	.42683	492	.63533	174	.87211	2
3	181	.24478	846	.43010	520	.63903	202	.87633	3
4	209	.24770	874	.43337	548	.64274	231	.88056	4
5	.69237	2.25062	.70902	2.43666	.72576	2.64645	.74259	2.88479	5
6	264	.25355	930	.43995	604	.65018	287	.88904	6
7	292	.25648	958	.44324	632	.65391	315	.89330	7
8	320	.25942	985	.44655	660	.65765	343	.89756	8
9	347	.26237	.71013	.44986	688	.66140	371	.90184	9
10	.69375	2.26531	.71041	2.45317	.72716	2.66515	.74399	2.90613	10
11	403	.26827	069	.45650	744	.66892	427	.91042	11
12	430	.27123	097	.45983	772	.67269	455	.91473	12
13	458	.27420	125	.46316	800	.67647	484	.91904	13
14	486	.27717	153	.46651	828	.68025	512	.92337	14
15	.69514	2.28015	.71180	2.46986	.72856	2.68405	.74540	2.92770	15
16	541	.28313	208	.47321	884	.68785	568	.93204	16
17	569	.28612	236	.47658	912	.69167	596	.93640	17
18	597	.28912	264	.47995	940	.69549	624	.94076	18
19	624	.29212	292	.48333	968	.69931	652	.94514	19
20	.69652	2.29512	.71320	2.48671	.72996	2.70315	.74680	2.94952	20
21	680	.29814	348	.49010	.73024	.70700	709	.95392	21
22	708	.30115	375	.49350	052	.71085	737	.95832	22
23	735	.30418	403	.49691	080	.71471	765	.96274	23
24	763	.30721	431	.50032	108	.71858	793	.96716	24
25	.69791	2.31024	.71459	2.50374	.73136	2.72246	.74821	2.97160	25
26	818	.31328	487	.50716	164	.72635	849	.97604	26
27	846	.31633	515	.51060	192	.73024	878	.98050	27
28	874	.31939	543	.51404	220	.73414	906	.98497	28
29	902	.32244	571	.51748	248	.73806	934	.98944	29
30	.69929	2.32551	.71598	2.52094	.73276	2.74198	.74962	2.99393	30
31	957	.32858	626	.52440	304	.74591	990	.99843	31
32	985	.33166	654	.52787	332	.74984	.75018	3.00293	32
33	.70013	.33474	682	.53134	360	.75379	046	.00745	33
34	040	.33783	710	.53482	388	.75775	075	.01198	34
35	.70068	2.34092	.71738	2.53831	.73416	2.76171	.75103	3.01652	35
36	096	.34403	766	.54181	444	.76568	131	.02107	36
37	124	.34713	794	.54531	472	.76966	159	.02563	37
38	151	.35025	822	.54883	500	.77365	187	.03020	38
39	179	.35336	850	.55234	529	.77765	216	.03479	39
40	.70207	2.35649	.71877	2.55587	.73557	2.78166	.75244	3 [illegible]38	40
41	235	.35962	905	.55940	585	.78568	272	[illegible]98	41
42	263	.36276	933	.56294	613	.78970	300	[illegible]60	42
43	290	.36590	961	.56649	641	.79374	328	[illegible]22	43
44	318	.36905	989	.57005	669	.79778	356	[illegible]86	44
45	.70346	2.37221	.72017	2.57361	.73697	2.80183	.75385	3 [illegible]51	45
46	374	.37537	045	.57718	725	.80589	413	[illegible]17	46
47	401	.37854	073	.58076	753	.80996	441	[illegible]84	47
48	429	.38171	101	.58434	781	.81404	469	[illegible]52	48
49	457	.38489	129	.58794	809	.81813	497	[illegible]21	49
50	.70485	2.38808	.72157	2.59154	.73837	2.82223	.75526	3.08591	50
51	513	.39128	185	.59514	865	.82633	554	.09063	51
52	540	.39448	213	.59876	893	.83045	582	.09535	52
53	568	.39768	241	.60238	921	.83457	610	.10009	53
54	596	.40089	269	.60601	950	.83871	638	.10484	54
55	.70624	2.40411	.72296	2.60965	.73978	2.84285	.75667	3.10960	55
56	652	.40734	324	.61330	.74006	.84700	695	.11437	56
57	679	.41057	352	.61695	034	.85116	723	.11915	57
58	707	.41381	380	.62061	062	.85533	751	.12394	58
59	735	.41705	408	.62428	090	.85951	780	.12875	59
60	.70763	2.42030	.72436	2.62796	.74118	2.86370	.75808	3.13357	60

M.	76° Vers.	76° Exsec.	77° Vers.	77° Exsec.	78° Vers.	78° Exsec.	79° Vers.	79° Exsec.	M.
0	.75808	3.13357	.77505	3.44541	.79209	3.80973	.80919	4.24084	0
1	836	.13839	533	.45102	237	.81633	948	.24870	1
2	864	.14323	562	.45664	266	.82294	976	.25658	2
3	892	.14809	590	.46228	294	.82956	.81005	.26448	3
4	921	.15295	618	.46793	323	.83621	033	.27241	4
5	.75949	3.15782	.77647	3.47360	.79351	3.84288	.81062	4.28036	5
6	977	.16271	675	.47928	380	.84956	090	.28833	6
7	.76005	.16761	703	.48498	408	.85627	119	.29634	7
8	034	.17252	732	.49069	437	.86299	148	.30436	8
9	062	.17744	760	.49642	465	.86973	176	.31241	9
10	.76090	3.18238	.77788	3.50216	.79493	3.87649	.81205	4.32049	10
11	118	.18733	817	.50791	522	.88327	233	.32859	11
12	147	.19228	845	.51368	550	.89007	262	.33671	12
13	175	.19725	874	.51947	579	.89689	290	.34486	13
14	203	.20224	902	.52527	607	.90373	319	.35304	14
15	.76231	3.20723	.77930	3.53109	.79636	3.91058	.81348	4.36124	15
16	260	.21224	959	.53692	664	.91746	376	.36947	16
17	288	.21726	987	.54277	693	.92436	405	.37772	17
18	316	.22229	.78015	.54863	721	.93128	433	.38600	18
19	344	.22734	044	.55451	750	.93821	462	.39430	19
20	.76373	3.23239	.78072	3.56041	.79778	3.94517	.81491	4.40263	20
21	401	.23746	101	.56632	807	.95215	519	.41099	21
22	429	.24255	129	.57224	835	.95914	548	.41937	22
23	458	.24764	157	.57819	864	.96616	576	.42778	23
24	486	.25275	186	.58414	892	.97320	605	.43622	24
25	.76514	3.25787	.78214	3.59012	.79921	3.98025	.81633	4.44468	25
26	542	.26300	242	.59611	949	.98733	662	.45317	26
27	571	.26814	271	.60211	978	.99443	691	.46169	27
28	599	.27330	299	.60813	.80006	4.00155	719	.47023	28
29	627	.27847	328	.61417	. 035	.00869	748	.47881	29
30	.76655	3.28366	.78356	3.62023	.80063	4.01585	.81776	4.48740	30
31	684	.28885	384	.62630	092	.02303	805	.49603	31
32	712	.29406	413	.63238	120	.03024	834	.50468	32
33	740	.29929	441	.63849	149	.03746	862	.51337	33
34	769	.30452	470	.64461	177	.04471	891	.52208	34
35	.76797	3.30977	.78498	3.65074	.80206	4.05197	.81919	4.53081	35
36	825	.31503	526	.65690	234	.05926	948	.53958	36
37	854	.32031	555	.66307	263	.06657	977	.54837	37
38	882	.32560	583	.66925	291	.07390	.82005	.55720	38
39	910	.33090	612	.67545	320	.08125	034	.56605	39
40	.76938	3.33622	.78640	3.68167	.80348	4.08863	.82063	4.57493	40
41	967	.34154	669	.68791	377	.09602	091	.58383	41
42	995	.34689	697	.69417	405	.10344	120	.59277	42
43	.77023	.35224	725	.70044	434	.11088	148	.60174	43
44	052	.35761	754	.70673	462	.11835	177	.61073	44
45	.77080	3.36299	.78782	3.71303	.80491	4.12583	.82206	4.61976	45
46	108	.36839	811	.71935	519	.13334	234	.62881	46
47	137	.37380	839	.72569	548	.14087	263	.63790	47
48	165	.37923	868	.73205	577	.14842	292	.64701	48
49	193	.38466	896	.73843	605	.15599	320	.65616	49
50	.77222	3.39012	.78924	3.74482	.80634	4.16359	.82349	4.66533	50
51	250	.39558	953	.75123	662	.17121	377	.67454	51
52	278	.40106	981	.75766	691	.17886	406	.68377	52
53	307	.40656	.79010	.76411	719	.18652	435	.69304	53
54	335	.41206	038	.77057	748	.19421	463	.70234	54
55	.77363	3.41759	.79067	3.77705	.80776	4.20193	.82492	4.71166	55
56	392	.42312	095	.78355	805	.20966	521	.72102	56
57	420	.42867	123	.79007	833	.21742	549	.73041	57
58	448	.43424	152	.79661	862	.22521	578	.73983	58
59	477	.43982	180	.80316	891	.23301	607	.74929	59
60	.77505	3.44541	.79209	3.80973	.80919	4.24084	.82635	4.75877	60

M	80° Vers.	80° Exsec.	81° Vers.	81° Exsec.	82° Vers.	82° Exsec.	83° Vers.	83° Exsec.	M.
0	.82635	4.75877	.84357	5.39245	.86083	6.18530	.87813	7.20551	0
1	664	.76829	385	.40422	111	.20020	842	.22500	1
2	692	.77783	414	.41602	140	.21517	871	.24457	2
3	721	.78742	443	.42787	169	.23019	900	.26425	3
4	750	.79703	471	.43977	198	.24529	929	.28402	4
5	.82778	4.80667	.84500	5.45171	.86227	6.26044	.87957	7.30388	5
6	807	.81635	529	.46369	256	.27566	986	.32384	6
7	836	.82606	558	.47572	284	.29095	.88015	.34390	7
8	864	.83581	586	.48779	313	.30630	044	.36405	8
9	893	.84558	615	.49991	342	.32171	073	.38431	9
10	.82922	4.85539	.84644	5.51208	.86371	6.33719	.88102	7.40466	10
11	950	.86524	673	.52429	400	.35274	131	.42511	11
12	979	.87511	701	.53655	428	.36835	160	.44566	12
13	.83008	.88502	730	.54886	457	.38403	188	.46632	13
14	036	.89497	759	.56121	486	.39978	217	.48707	14
15	.83065	4.90495	.84788	5.57361	.86515	6.41560	.88246	7.50793	15
16	094	.91496	816	.58606	544	.43148	275	.52889	16
17	122	.92501	845	.59855	573	.44743	304	.54996	17
18	151	.93509	874	.61110	601	.46346	333	.57113	18
19	180	.94521	903	.62369	630	.47955	362	.59241	19
20	.83208	4.95536	.84931	5.63633	.86659	6.49571	.88391	7.61379	20
21	237	.96555	960	.64902	688	.51194	420	.63528	21
22	266	.97577	989	.66176	717	.52825	448	.65688	22
23	294	.98603	.85018	.67454	746	.54462	477	.67859	23
24	323	.99633	046	.68738	774	.56107	506	.70041	24
25	.83352	5.00666	.85075	5.70027	.86803	6.57759	.88535	7.72234	25
26	380	.01702	104	.71321	832	.59418	564	.74438	26
27	409	.02743	133	.72620	861	.61085	593	.76653	27
28	438	.03787	162	.73924	890	.62759	622	.78880	28
29	467	.04834	190	.75233	919	.64441	651	.81118	29
30	.83495	5.05886	.85219	5.76547	.86947	6.66130	.88680	7.83367	30
31	524	.06941	248	.77866	976	.67826	709	.85628	31
32	553	.08000	277	.79191	87005	.69530	737	.87901	32
33	581	.09062	305	.80521	034	.71242	766	.90186	33
34	610	.10129	334	.81856	063	.72962	795	.92482	34
35	.83639	5.11199	.85363	5.83196	.87092	6.74689	.88824	7.94791	35
36	667	.12273	392	.84542	120	.76424	853	.97111	36
37	696	.13350	420	.85893	149	.78167	882	.99444	37
38	725	.14432	449	.87250	178	.79918	911	8.01788	38
39	754	.15517	478	.88612	207	.81677	940	.04146	39
40	.83782	5.16607	.85507	5.89979	.87236	6.83443	.88969	8.06515	40
41	811	.17700	536	.91352	265	.85218	998	.08897	41
42	840	.18797	564	.92731	294	.87001	.89027	.11292	42
43	868	.19898	593	.94115	322	.88792	055	.13699	43
44	897	.21004	622	.95505	351	.90592	084	.16120	44
45	.83926	5.22113	.85651	5.96900	.87380	6.92399	.89113	8.18553	45
46	954	.23226	680	.98301	409	.94216	142	.20999	46
47	983	.24343	708	.99708	438	.96040	171	.23459	47
48	.84012	.25464	737	6.01120	467	.97873	200	.25931	48
49	041	.26590	766	.02538	496	.99714	229	.28417	49
50	.84069	5.27719	.85795	6.03962	.87524	7.01565	.89258	8.30917	50
51	098	.28853	823	.05392	553	.03423	287	.33430	51
52	127	.29991	852	.06828	582	.05291	316	.35957	52
53	155	.31133	881	.08269	611	.07167	345	.38497	53
54	184	.32279	910	.09717	640	.09052	374	.41052	54
55	.84213	5.33429	.85939	6.11171	.87669	7.10946	.89403	8.43620	55
56	242	.34584	967	.12630	698	.12849	431	.46203	56
57	270	.35743	996	.14096	726	.14760	460	.48800	57
58	299	.36906	.86025	.15568	755	.16681	489	.51411	58
59	328	.38073	054	.17046	784	.18612	518	.54037	59
60	.84357	5.39245	.86083	6.18530	.87813	7.20551	.89547	8.56677	60

M.	84° Vers.	84° Exsec.	85° Vers.	85° Exsec.	86° Vers.	86° Exsec.	M.
0	.89547	8.56677	.91284	10.47371	.93024	13.33559	0
1	576	.59332	313	.51199	053	.39547	1
2	605	.62002	342	.55052	082	.45586	2
3	634	.64687	371	.58932	111	.51676	3
4	663	.67387	400	.62837	140	.57817	4
5	.89692	8.70103	.91429	10.66769	.93169	13.64011	5
6	721	.72833	458	.70728	198	.70258	6
7	750	.75579	487	.74714	227	.76558	7
8	779	.78341	516	.78727	257	.82913	8
9	808	.81119	545	.82768	286	.89323	9
10	.89836	8.83912	.91574	10.86837	.93315	13.95788	10
11	865	.86722	603	.90934	344	14.02310	11
12	894	.89547	632	.95060	373	.08890	12
13	923	.92389	661	.99214	402	.15527	13
14	952	.95248	690	11.03397	431	.22223	14
15	.89981	8.98123	.91719	11.07610	.93460	14.28979	15
16	.90010	9.01015	748	.11852	489	.35795	16
17	039	.03923	777	.16125	518	.42672	17
18	068	.06849	806	.20427	547	.49611	18
19	097	.09792	835	.24761	576	.56613	19
20	.90126	9.12752	.91864	11.29125	.93605	14.63679	20
21	155	.15730	893	.33521	634	.70810	21
22	184	.18725	922	.37948	663	.78005	22
23	213	.21739	951	.42408	692	.85268	23
24	242	.24770	980	.46900	721	.92597	24
25	.90271	9.27819	.92009	11.51424	.93750	14.99995	25
26	300	.30887	038	.55981	779	15.07462	26
27	329	.33973	067	.60572	808	.14999	27
28	358	.37077	096	.65197	837	.22607	28
29	386	.40201	125	.69856	866	.30287	29
30	.90415	9.43343	.92154	11.74549	.93895	15.38041	30
31	444	.46505	183	.79278	924	.45869	31
32	473	.49685	212	.84042	953	.53772	32
33	502	.52886	241	.88841	982	.61751	33
34	531	.56106	270	.93677	.94011	.69808	34
35	.90560	9.59346	.92299	11.98549	.94040	15.77944	35
36	589	.62605	328	12.03458	069	.86159	36
37	618	.65885	357	.08404	098	.94456	37
38	647	.69186	386	.13388	127	16.02835	38
39	676	.72507	415	.18411	156	.11297	39
40	.90705	9.75849	.92444	12.23472	.94186	16.19843	40
41	734	.79212	473	.28572	215	.28476	41
42	763	.82596	502	.33712	244	.37196	42
43	792	.86001	531	.38891	273	.46005	43
44	821	.89428	560	.44112	302	.54903	44
45	.90850	9.92877	.92589	12.49373	.94331	16.63893	45
46	879	.96348	618	.54676	360	.72975	46
47	908	.99841	647	.60021	389	.82152	47
48	937	10.03356	676	.65408	418	.91424	48
49	966	.06894	705	.70838	447	17.00794	49
50	.90995	10.10455	.92734	12.76311	.94476	17.10262	50
51	.91024	.14039	763	.81829	505	.19830	51
52	053	.17646	792	.87391	534	.29500	52
53	082	.21277	821	.92999	563	.39274	53
54	111	.24932	850	.98651	592	.49153	54
55	.91140	10.28610	.92879	13.04350	.94621	17.59139	55
56	169	.32313	908	.10096	650	.69233	56
57	197	.36040	937	.15889	679	.79438	57
58	226	.39792	966	.21730	708	.89755	58
59	255	.43569	995	.27620	737	18.00185	59
60	.91284	10.47371	.93024	13.33559	.94766	18.10732	60

M.	87°		88°		89°		M.
	Vers.	Exsec.	Vers.	Exsec.	Vers.	Exsec.	
0	.94766	18.10732	.96510	27.65371	.98255	56.29869	0
1	795	.21397	539	.89440	284	57.26975	1
2	825	.32182	568	28.13917	313	58.27431	2
3	854	.43088	597	.38812	342	59.31411	3
4	883	.54119	626	.64137	371	60.39105	4
5	.94912	18.65275	.96655	28.89903	.98400	61.50715	5
6	941	.76560	684	29.16120	429	62.66460	6
7	970	.87976	714	.42802	458	63.86572	7
8	999	.99524	743	.69960	487	65.11304	8
9	.95028	19.11207	772	.97607	517	66.40927	9
10	.95057	19.23028	.96801	30.25758	.98546	67.75736	10
11	086	.34989	830	.54425	575	69.16047	11
12	115	.47093	859	.83623	604	70.62205	12
13	144	.59341	888	31.13366	633	72.14583	13
14	173	.71737	917	.43671	662	73.73586	14
15	.95202	19.84283	.96946	31.74554	.98691	75.39655	15
16	231	.96982	975	32.06030	720	77.13274	16
17	260	20.09838	.97004	.38118	749	78.94968	17
18	289	.22852	033	.70835	778	80.85315	18
19	318	.36027	062	33.04199	807	82.84947	19
20	.95347	20.49368	.97092	33.38232	.98836	84.94561	20
21	377	.62876	121	.72951	866	87.14924	21
22	406	.76555	150	34.08380	895	89.46886	22
23	435	.90409	179	.44539	924	91.91387	23
24	464	21.04440	208	.81452	953	94.49471	24
25	.95493	21.18653	.97237	35.19141	.98982	97.22303	25
26	522	.33050	266	.57633	.99011	100.11185	26
27	551	.47635	295	.96953	040	103.17574	27
28	580	.62413	324	36.37127	069	106.43114	28
29	609	.77386	353	.78185	098	109.89656	29
30	.95638	21.92559	.97382	37.20155	.99127	113.59301	30
31	667	22.07935	411	.63068	156	117.54440	31
32	696	.23520	440	38.06957	186	121.77803	32
33	725	.39316	470	.51855	215	126.32526	33
34	754	.55329	499	.97797	244	131.22229	34
35	.95783	22.71563	.97528	39.44820	.99273	136.51108	35
36	812	.88022	557	.92963	302	142.24061	36
37	841	23.04712	586	40.42266	331	148.46837	37
38	871	.21637	615	.92772	360	155.26228	38
39	900	.38802	644	41.44525	389	162.70325	39
40	.95929	23.56212	.97673	41.97571	.99418	170.88831	40
41	958	.73873	702	42.51961	447	179.93496	41
42	987	.91790	731	43.07746	476	189.98680	42
43	.96016	24.09969	760	.64980	505	201.22122	43
44	045	.28414	789	44.23719	535	213.85995	44
45	.96074	24.47134	.97819	44.84026	.99564	228.18385	45
46	103	.66132	848	45.45963	593	244.55402	46
47	132	.85417	877	46.09596	622	263.44269	47
48	161	25.04994	906	.74997	651	285.47948	48
49	190	.24869	935	47.42241	680	311.52297	49
50	.96219	25.45051	.97964	48.11406	.99709	342.77516	50
51	248	.65545	993	.82576	738	380.97230	51
52	277	.86360	.98022	49.55840	767	428.71873	52
53	307	26.07503	051	50.31290	796	490.10702	53
54	336	.28981	080	51.09027	825	571.95809	54
55	.96365	26.50804	.98109	51.89156	.99855	686.54960	55
56	394	.72978	138	52.71790	884	858.43689	56
57	423	.95512	168	53.57046	913	1144.91574	57
58	452	27.18417	197	54.45053	942	1717.87348	58
59	481	.41700	226	55.35946	971	3436.74682	59
60	.96510	27.65371	.98255	56.29869	1.00000	∞	60

TABLE XX.—LENGTHS OF CIRCULAR ARCS; RADIUS=1.

Sec.	Length.	Min.	Length.	Deg.	Length.	Deg.	Length.
1	.0000048	1	.0002909	1	.0174533	61	1.0646508
2	00097	2	05818	2	.0349066	62	.0821041
3	00145	3	08727	3	.0523599	63	.0995574
4	00194	4	11636	4	.0698132	64	.1170107
5	.0000242	5	.0014544	5	.0872665	65	1.1344640
6	00291	6	17453	6	.1047198	66	.1519173
7	00339	7	20362	7	.1221730	67	.1693706
8	00388	8	23271	8	.1396263	68	.1868239
9	00436	9	26180	9	.1570796	69	.2042772
10	.0000485	10	.0029089	10	.1745329	70	1.2217305
11	00533	11	31998	11	.1919862	71	.2391838
12	00582	12	34907	12	.2094395	72	.2566371
13	00630	13	37815	13	.2268928	73	.2740904
14	00679	14	40724	14	.2443461	74	.2915436
15	.0000727	15	.0043633	15	.2617994	75	1.3089969
16	00776	16	46542	16	.2792527	76	.3264502
17	00824	17	49451	17	.2967060	77	.3439035
18	00873	18	52360	18	.3141593	78	.3613568
19	00921	19	55269	19	.3316126	79	.3788101
20	.0000970	20	.0058178	20	.3490659	80	1.3962634
21	01018	21	61087	21	.3665191	81	.4137167
22	01067	22	63995	22	.3839724	82	.4311700
23	01115	23	66904	23	.4014257	83	.4486233
24	01164	24	69813	24	.4188790	84	.4660766
25	.0001212	25	.0072722	25	.4363323	85	1.4835299
26	01261	26	75631	26	.4537856	86	.5009832
27	01309	27	78540	27	.4712389	87	.5184364
28	01357	28	81449	28	.4886922	88	.5358897
29	01406	29	84358	29	.5061455	89	.5533430
30	.0001454	30	.0087266	30	.5235988	90	1.5707963
31	01503	31	90175	31	.5410521	91	.5882496
32	01551	32	93084	32	.5585054	92	.6057029
33	01600	33	95993	33	.5759587	93	.6231562
34	01648	34	98902	34	.5934119	94	.6406095
35	.0001697	35	.0101811	35	.6108652	95	1.6580628
36	01745	36	04720	36	.6283185	96	.6755161
37	01794	37	07629	37	.6457718	97	.6929694
38	01842	38	10538	38	.6632251	98	.7104227
39	01891	39	13446	39	.6806784	99	.7278760
40	.0001939	40	.0116355	40	.6981317	100	1.7453293
41	01988	41	19264	41	.7155850	101	.7627825
42	02036	42	22173	42	.7330383	102	.7802358
43	02085	43	25082	43	.7504916	103	.7976891
44	02133	44	27991	44	.7679449	104	.8151424
45	.0002182	45	.0130900	45	.7853982	105	1.8325957
46	02230	46	33809	46	.8028515	106	.8500490
47	02279	47	36717	47	.8203047	107	.8675023
48	02327	48	39626	48	.8377580	108	.8849556
49	·02376	49	42535	49	.8552113	109	.9024089
50	.0002424	50	.0145444	50	.8726646	110	1.9198622
51	02473	51	48353	51	.8901179	111	.9373155
52	02521	52	51262	52	.9075712	112	.9547688
53	02570	53	54171	53	.9250245	113	.9722221
54	02618	54	57080	54	.9424778	114	.9896753
55	.0002666	55	.0159989	55	.9599311	115	2.0071286
56	02715	56	62897	56	.9773844	116	.0245819
57	02763	57	65806	57	.9948377	117	.0420352
58	02812	58	68715	58	1.0122910	118	.0594885
59	02860	59	71624	59	1.0297443	119	.0769418
60	.0002909	60	.0174533	60	1.0471976	120	2.0943951

TABLE XX.A.—DIFFERENCES BETWEEN ARCS AND CHORDS; R = 1

Min.	1°	2°	3°	4°	5°	6°	7°	Min.
0	.000000	.000002	.000006	.000014	.000028	.000048	.000076	0
1	000	002	006	014	028	048	077	1
2	000	002	006	015	028	049	077	2
3	000	002	006	015	029	049	078	3
4	000	002	006	015	029	049	078	4
5	.000000	.000002	.000006	.000015	.000029	.000050	.000079	5
6	000	002	007	015	029	050	079	6
7	000	002	007	015	030	051	080	7
8	000	002	007	016	030	051	080	8
9	000	002	007	016	030	052	081	9
10	.000000	.000002	.000007	.000016	.000031	.000052	.000082	10
11	000	002	007	016	031	052	082	11
12	000	002	007	016	031	053	083	12
13	000	002	007	017	031	053	083	13
14	000	002	007	017	032	054	084	14
15	.000000	.000003	.000008	.000017	.000032	.000054	.000084	15
16	000	003	008	017	032	055	085	16
17	000	003	008	017	033	055	086	17
18	000	003	008	018	033	055	086	18
19	001	003	008	018	033	056	087	19
20	.000001	.000003	.000008	.000018	.000034	.000056	.000087	20
21	001	003	008	018	034	057	088	21
22	001	003	008	018	034	057	089	22
23	001	003	009	019	035	058	089	23
24	001	003	009	019	035	058	090	24
25	.000001	.000003	.000009	.000019	.000035	.000059	.000090	25
26	001	003	009	019	036	059	091	26
27	001	003	009	020	036	059	092	27
28	001	003	009	020	036	060	092	28
29	001	003	009	020	037	060	093	29
30	.000001	.000003	.000009	.000020	.000037	.000061	.000093	30
31	001	004	010	020	037	061	094	31
32	001	004	010	021	038	062	095	32
33	001	004	010	021	038	062	095	33
34	001	004	010	021	038	063	096	34
35	.000001	.000004	.000010	.000021	.000039	.000063	.000097	35
36	001	004	010	022	039	064	097	36
37	001	004	010	022	039	064	098	37
38	001	004	011	022	040	065	099	38
39	001	004	011	022	040	065	099	39
40	.000001	.000004	.000011	.000023	.000040	.000066	.000100	40
41	001	004	011	023	041	066	100	41
42	001	004	011	023	041	067	101	42
43	001	004	011	023	041	067	102	43
44	001	005	012	023	042	068	102	44
45	.000001	.000005	.000012	.000024	.000042	.000068	.000103	45
46	001	005	012	024	043	069	104	46
47	001	005	012	024	043	069	104	47
48	001	005	012	024	043	070	105	48
49	001	005	012	025	044	070	106	49
50	.000001	.000005	.000012	.000025	.000044	.000071	.000106	50
51	001	005	013	025	044	071	107	51
52	001	005	013	026	045	072	108	52
53	001	005	013	026	045	072	109	53
54	002	005	013	026	045	073	109	54
55	.000002	.000005	.000013	.000026	.000046	.000073	.000110	55
56	002	006	013	027	046	074	111	56
57	002	006	014	027	047	074	111	57
58	002	006	014	027	047	075	112	58
59	002	006	014	027	047	075	113	59
60	.000002	.000006	.000014	.000028	.000048	.000076	.000113	60
Min.	1°	2°	3°	4°	5°	6°	7°	Min.

TABLE XX.A.—DIFFERENCES BETWEEN ARCS AND CHORDS; R = 1

Min.	8°	9°	10°	11°	12°	13°	14°	Min.
0	.000113	.000161	.000221	.000295	.000383	.000486	.000607	0
1	114	162	223	296	384	488	610	1
2	115	163	224	297	386	490	612	2
3	116	164	225	299	387	492	614	3
4	116	165	226	300	389	494	616	4
5	.000117	.000166	.000227	.000301	.000391	.000496	.000618	5
6	118	167	228	303	392	498	621	6
7	118	168	229	304	394	500	623	7
8	119	169	230	306	395	501	625	8
9	120	170	232	307	397	503	627	9
10	.000121	.000171	.000233	.000308	.000399	.000505	.000629	10
11	121	172	234	310	400	507	632	11
12	122	172	235	311	402	509	634	12
13	123	173	236	312	404	511	636	13
14	124	174	237	314	405	513	638	14
15	.000124	.000175	.000238	.000315	.000407	.000515	.000641	15
16	125	176	240	317	409	517	643	16
17	126	177	241	318	410	519	645	17
18	127	178	242	319	412	521	647	18
19	127	179	243	321	414	523	650	19
20	.000128	.000180	.000244	.000322	.000415	.000525	.000652	20
21	129	181	246	324	417	527	654	21
22	130	182	247	325	419	529	656	22
23	130	183	248	327	420	531	659	23
24	131	184	249	328	422	533	661	24
25	.000132	.000185	.000250	.000329	.000424	.000535	.000663	25
26	133	186	251	331	426	537	666	26
27	134	187	253	332	427	539	668	27
28	134	188	254	334	429	541	670	28
29	135	189	255	335	431	543	672	29
30	.000136	.000190	.000256	.000337	.000432	.000545	.000675	30
31	137	191	258	338	434	547	677	31
32	138	192	259	340	436	549	679	32
33	138	193	260	341	438	551	682	33
34	139	194	261	343	439	553	684	34
35	.000140	.000195	.000262	.000344	.000441	.000555	.000686	35
36	141	196	264	346	443	557	689	36
37	142	197	265	347	445	559	691	37
38	143	198	266	349	446	561	694	38
39	143	199	267	350	448	563	696	39
40	.000144	.000200	.000269	.000352	.000450	.000565	.000698	40
41	145	201	270	353	452	567	701	41
42	146	202	271	355	453	569	703	42
43	147	203	273	356	455	571	705	43
44	148	204	274	358	457	573	708	44
45	.000148	.000205	.000275	.000359	.000459	.000575	.000710	45
46	149	206	276	361	461	578	713	46
47	150	207	278	362	462	580	715	47
48	151	208	279	364	464	582	718	48
49	152	209	280	365	466	584	720	49
50	.000153	.000211	.000282	.000367	.000468	.000586	.000722	50
51	154	212	283	368	470	588	725	51
52	154	213	284	370	472	590	727	52
53	155	214	285	372	473	592	730	53
54	156	215	287	373	475	594	732	54
55	.000157	.000216	.000288	.000375	.000477	.000597	.000735	55
56	158	217	289	376	479	599	737	56
57	159	218	291	378	481	601	740	57
58	160	219	292	379	483	603	742	58
59	161	220	293	381	485	605	745	59
60	.000161	.000221	.000295	.000383	.000486	.000607	.000747	60
Min.	8°	9°	10°	11°	12°	13°	14°	Min.

TABLE XX.A.—DIFFERENCES BETWEEN ARCS AND CHORDS; R = 1

Min.	15°	16°	17°	18°	19°	20°	21°	Min.
0	.000747	.000906	.001087	.001290	.001517	.001767	.002048	0
1	750	909	090	294	521	774	053	1
2	752	912	094	298	525	778	058	2
3	755	915	097	301	529	783	063	3
4	757	918	100	305	533	787	068	4
5	.000760	.000921	.001103	.001308	.001537	.001792	.002073	5
6	762	924	106	312	541	796	077	6
7	765	926	110	316	545	801	082	7
8	767	929	113	319	549	805	087	8
9	770	932	116	323	554	810	092	9
10	.000772	.000935	.001119	.001326	.001558	.001814	.002097	10
11	775	938	123	330	562	819	102	11
12	777	941	126	334	566	823	107	12
13	780	944	129	337	570	828	112	13
14	782	947	132	341	574	832	117	14
15	.000785	.000950	.001136	.001345	.001578	.001837	.002122	15
16	788	953	139	348	582	841	127	16
17	790	955	142	352	586	846	132	17
18	793	958	146	356	590	850	137	18
19	795	961	149	360	594	855	142	19
20	.000798	.000964	.001152	.001363	.001599	.001859	.002147	20
21	800	967	156	367	603	864	152	21
22	803	970	159	371	607	869	157	22
23	806	973	162	374	611	873	162	23
24	808	976	166	378	615	878	167	24
25	.000811	.000979	.001169	.001382	.001619	.001882	.002172	25
26	814	982	172	386	623	887	177	26
27	816	985	176	389	628	892	182	27
28	819	988	179	393	632	896	188	28
29	822	991	182	397	636	901	193	29
30	.000824	.000994	.001186	.001401	.001640	.001905	.002198	30
31	827	997	189	405	644	910	203	31
32	830	.001000	193	408	649	915	208	32
33	832	003	196	412	653	919	213	33
34	835	006	199	416	657	924	218	34
35	.000838	.001009	.001203	.001420	.001661	.001929	.002223	35
36	840	012	206	424	666	933	228	36
37	843	015	210	427	670	938	234	37
38	846	018	213	431	674	943	239	38
39	848	021	217	435	678	948	244	39
40	.000851	.001024	.001220	.001439	.001683	.001952	.002249	40
41	854	028	223	443	687	957	254	41
42	856	031	227	447	691	962	260	42
43	859	034	230	451	695	966	265	43
44	862	037	234	454	700	971	270	44
45	.000865	.001040	.001237	.001458	.001704	.001976	.002275	45
46	867	043	241	462	708	981	280	46
47	870	046	244	466	713	985	286	47
48	873	049	248	470	717	990	291	48
49	876	052	251	474	721	995	296	49
50	.000878	.001056	.001255	.001478	.001726	.002000	.002301	50
51	881	059	258	482	730	005	307	51
52	884	062	262	486	734	009	312	52
53	887	065	265	490	739	014	317	53
54	890	068	269	494	743	019	323	54
55	.000892	.001071	.001273	.001497	.001747	.002024	.002328	55
56	895	074	276	501	752	029	333	56
57	898	078	280	505	756	034	338	57
58	901	081	283	509	761	038	344	58
59	904	084	287	513	765	043	349	59
60	.000906	.001087	.001290	.001517	.001769	.002048	.002354	60
Min.	15°	16°	17°	18°	19°	20°	21°	Min.

TABLE XX.A.—DIFFERENCES BETWEEN ARCS AND CHORDS; R = 1

Min.	22°	23°	24°	25°	26°	27°	28°	Min.
0	.002354	.002690	.003056	.003453	.003883	.004348	.004848	0
1	360	696	062	460	891	356	857	1
2	365	702	068	467	898	364	866	2
3	371	707	075	474	906	372	874	3
4	376	713	081	481	913	380	883	4
5	.002381	.002719	.003088	.003488	.003921	.004388	.004892	5
6	387	725	094	495	928	397	900	6
7	392	731	100	502	936	405	909	7
8	397	737	107	509	943	413	918	8
9	403	743	113	516	951	421	927	9
10	.002408	.002749	.003120	.003523	.003959	.004429	.004935	10
11	414	755	126	530	966	437	944	11
12	419	761	133	537	974	445	953	12
13	425	766	139	544	981	453	962	13
14	430	772	146	551	989	462	970	14
15	.002436	.002778	.003152	.003558	.003996	.004470	.004979	15
16	441	784	158	565	.004004	478	988	16
17	447	790	165	572	012	486	997	17
18	452	796	171	579	019	494	.005006	18
19	457	802	178	586	027	503	014	19
20	.002463	.002808	.003185	.003593	.004035	.004511	.005023	20
21	468	814	191	600	042	519	032	21
22	474	820	198	607	050	527	041	22
23	480	826	204	614	057	536	050	23
24	485	832	211	621	065	544	059	24
25	.002491	.002838	.003217	.003628	.004073	.004552	.005068	25
26	496	845	224	635	081	561	077	26
27	502	851	230	643	088	569	085	27
28	507	857	237	650	096	577	094	28
29	513	863	244	657	104	585	103	29
30	.002518	.002869	.003250	.003664	.004111	.004594	.005112	30
31	524	875	257	671	119	602	121	31
32	530	881	264	678	127	610	130	32
33	535	887	270	686	135	619	139	33
34	541	893	277	693	143	627	148	34
35	.002546	.002899	.003284	.003700	.004150	.004636	.005157	35
36	552	906	290	707	158	644	166	36
37	558	912	297	715	166	652	175	37
38	563	918	304	722	174	661	184	38
39	569	924	310	729	182	669	193	39
40	.002575	.002930	.003317	.003736	.004189	.004678	.005202	40
41	580	936	324	744	197	686	211	41
42	586	943	330	751	205	695	220	42
43	592	949	337	758	213	703	229	43
44	597	955	344	765	221	711	239	44
45	.002603	.002961	.003351	.003773	.004229	.004720	.005248	45
46	609	968	357	780	237	728	257	46
47	615	974	364	787	245	737	266	47
48	620	980	371	795	252	745	275	48
49	626	986	378	802	260	754	284	49
50	.002632	.002993	.003385	.003809	.004268	.004763	.005293	50
51	638	999	391	817	276	771	303	51
52	643	.003005	398	824	284	780	312	52
53	649	011	405	831	292	788	321	53
54	655	018	412	839	300	797	330	54
55	.002661	.003024	.003419	.003846	.004308	.004805	.005339	55
56	667	030	426	854	316	814	349	56
57	672	037	432	861	324	823	358	57
58	678	043	439	869	332	831	367	58
59	684	049	446	876	340	840	376	59
60	.002690	.003056	.003453	.003883	.004348	.004848	.005385	60
Min.	22°	23°	24°	25°	26°	27°	28°	Min.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.	No.
1	1	1	1.0000000	1.0000000	1.000000000	1
2	4	8	.4142136	.2599210	.500000000	2
3	9	27	.7320508	.4422496	.333333333	3
4	16	64	2.0000000	.5874011	.250000000	4
5	25	125	2.2360680	1.7099759	.200000000	5
6	36	216	.4494897	.8171206	.166666667	6
7	49	343	.6457513	.9129312	.142857143	7
8	64	512	.8284271	2.0000000	.125000000	8
9	81	729	3.0000000	.0800837	.111111111	9
10	100	1000	3.1622777	2.1544347	.100000000	10
11	121	1331	.3166248	.2239801	.090909091	11
12	144	1728	.4641016	.2894286	.083333333	12
13	169	2197	.6055513	.3513347	.076923077	13
14	196	2744	.7416574	.4101422	1428571	14
15	225	3375	3.8729833	2.4662121	.066666667	15
16	256	4096	4.0000000	.5198421	2500000	16
17	289	4913	.1231056	.5712816	.058823529	17
18	324	5832	.2426407	.6207414	5555556	18
19	361	6859	.3588989	.6684016	2631579	19
20	400	8000	4.4721360	2.7144177	.050000000	20
21	441	9261	.5825757	.7589243	.047619048	21
22	484	10648	.6904158	.8020393	5454545	22
23	529	12167	.7958315	.8438670	3478261	23
24	576	13824	.8989795	.8844991	1666667	24
25	625	15625	5.0000000	2.9240177	.040000000	25
26	676	17576	.0990195	.9624960	.038461538	26
27	729	19683	.1961524	3.0000000	7037037	27
28	784	21952	.2915026	.0365889	5714286	28
29	841	24389	.3851648	.0723168	4482759	29
30	900	27000	5.4772256	3.1072325	.033333333	30
31	961	29791	.5677644	.1413806	2258065	31
32	1024	32768	.6568542	.1748021	1250000	32
33	1089	35937	.7445626	.2075343	0303030	33
34	1156	39304	.8309519	.2396118	.029411765	34
35	1225	42875	5.9160798	3.2710663	.028571429	35
36	1296	46656	6.0000000	.3019272	7777778	36
37	1369	50653	.0827625	.3322218	7027027	37
38	1444	54872	.1644140	.3619754	6315789	38
39	1521	59319	.2449980	.3912114	5641026	39
40	1600	64000	6.3245553	3.4199519	.025000000	40
41	1681	68921	.4031242	.4482172	4390244	41
42	1764	74088	.4807407	.4760266	3809524	42
43	1849	79507	.5574385	.5033981	3255814	43
44	1936	85184	.6332496	.5303483	2727273	44
45	2025	91125	6.7082039	3.5568933	.022222222	45
46	2116	97336	.7823300	.5830479	1739130	46
47	2209	103823	.8556546	.6088261	1276600	47
48	2304	110592	.9282032	.6342411	0833333	48
49	2401	117649	7.0000000	.6593057	0408163	49
50	2500	125000	7.0710678	3.6840314	.020000000	50
51	2601	132651	.1414284	.7084298	.019607843	51
52	2704	140608	.2111026	.7325111	9230769	52
53	2809	148877	.2801099	.7562858	8867925	53
54	2916	157464	.3484692	.7797631	8518519	54
55	3025	166375	7.4161985	3.8029525	.018181818	55
56	3136	175616	.4833148	.8258624	7857143	56
57	3249	185193	.5498344	.8485011	7543860	57
58	3364	195112	.6157731	.8708766	7241379	58
59	3481	205379	.6811457	.8929965	6949153	59

No.	Squares.	Cubes.	Square Roots.	Cube Roots.		
60	3600	216000	7.7459667	3.9148676	.016666667	60
61	3721	226981	.8102497	.9364972	6393443	61
62	3844	238328	.8740079	.9578915	6129032	62
63	3969	250047	.9372539	.9790571	5873016	63
64	4096	262144	8.0000000	4.0000000	5625000	64
65	4225	274625	8.0622577	4.0207256	.015384615	65
66	4356	287496	.1240384	.0412401	5151515	66
67	4489	300763	.1853528	.0615480	4925373	67
68	4624	314432	.2462113	.0816551	4705882	68
69	4761	328509	.3066239	.1015661	4492754	69
70	4900	343000	8.3666003	4.1212853	.014285714	70
71	5041	357911	.4261498	.1408178	4084507	71
72	5184	373248	.4852814	.1601676	3888889	72
73	5329	389017	.5440037	.1793392	3698630	73
74	5476	405224	.6023253	.1983364	3513514	74
75	5625	421875	8.6602540	4.2171633	.013333333	75
76	5776	438976	.7177979	.2358236	3157895	76
77	5929	456533	.7749644	.2543210	2987013	77
78	6084	474552	.8317609	.2726586	2820513	78
79	6241	493039	.8881944	.2908404	2658228	79
80	6400	512000	8.9442719	4.3088695	.012500000	80
81	6561	531441	9.0000000	.3267487	2345679	81
82	6724	551368	.0553851	.3444815	2195122	82
83	6889	571787	.1104336	.3620707	2048193	83
84	7056	592704	.1651514	.3795191	1904762	84
85	7225	614125	9.2195445	4.3968296	.011764706	85
86	7396	636056	.2736185	.4140049	1627907	86
87	7569	658503	.3273791	.4310476	1494253	87
88	7744	681472	.3808315	.4479602	1363636	88
89	7921	704969	.4339811	.4647451	1235955	89
90	8100	729000	9.4868330	4.4814047	.011111111	90
91	8281	753571	.5393920	.4979414	0989011	91
92	8464	778688	.5916630	.5143574	0869565	92
93	8649	804357	.6436508	.5306549	0752688	93
94	8836	830584	.6953597	.5468359	0638298	94
95	9025	857375	9.7467943	4.5629026	.010526316	95
96	9216	884736	.7979590	.5788570	0416667	96
97	9409	912673	.8488578	.5947009	0309278	97
98	9604	941192	.8994949	.6104363	0204082	98
99	9801	970299	.9498744	.6260650	0101010	99
100	10000	1000000	10.0000000	4.6415888	.010000000	100
101	10201	1030301	.0498756	.6570095	.009900990	101
102	10404	1061208	.0995049	.6723287	9803922	102
103	10609	1092727	.1488916	.6875482	9708738	103
104	10816	1124864	.1980390	.7026694	9615385	104
105	11025	1157625	10.2469508	4.7176940	.009523810	105
106	11236	1191016	.2956301	.7326235	9433962	106
107	11449	1225043	.3440804	.7474594	9345794	107
108	11664	1259712	.3923048	.7622032	9259259	108
109	11881	1295029	.4403065	.7768562	9174312	109
110	12100	1331000	10.4880885	4.7914199	.009090909	110
111	12321	1367631	.5356538	.8058955	9009009	111
112	12544	1404928	.5830052	.8202845	8928571	112
113	12769	1442897	.6301458	.8345881	8849558	113
114	12996	1481544	.6770783	.8488076	8771930	114
115	13225	1520875	10.7238053	4.8629442	.008695652	115
116	13456	1560896	.7703296	.8769990	8620690	116
117	13689	1601613	.8166538	.8909732	8547009	117
118	13924	1643032	.8627805	.9048681	8474576	118
119	14161	1685159	.9087121	.9186847	8403361	119

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.	No.
123	15129	1860867	.0905365	.9731898	8130081	123
124	15376	1906624	.1355287	.9866310	8064516	124
125	15625	1953125	11.1803399	5.0000000	.008000000	125
126	15876	2000376	.2249722	.0132979	7936508	126
127	16129	2048383	.2694277	.0265257	7874016	127
128	16384	2097152	.3137085	.0396842	7812500	128
129	16641	2146689	.3578167	.0527743	7751938	129
130	16900	2197000	11.4017543	5.0657970	.007692308	130
131	17161	2248091	.4455231	.0787531	7633588	131
132	17424	2299968	.4891253	.0916434	7575758	132
133	17689	2352637	.5325626	.1044687	7518797	133
134	17956	2406104	.5758369	.1172299	7462687	134
135	18225	2460375	11.6189500	5.1299278	.007407407	135
136	18496	2515456	.6619038	.1425632	7352941	136
137	18769	2571353	.7046999	.1551367	7299270	137
138	19044	2628072	.7473401	.1676493	7246377	138
139	19321	2685619	.7898261	.1801015	7194245	139
140	19600	2744000	11.8321596	5.1924941	.007142857	140
141	19881	2803221	.8743421	.2048279	7092199	141
142	20164	2863288	.9163753	.2171034	7042254	142
143	20449	2924207	.9582607	.2293215	6993007	143
144	20736	2985984	12.0000000	.2414828	6944444	144
145	21025	3048625	12.0415946	5.2535879	.006896552	145
146	21316	3112136	.0830460	.2656374	6849315	146
147	21609	3176523	.1243557	.2776321	6802721	147
148	21904	3241792	.1655251	.2895725	6756757	148
149	22201	3307949	.2065556	.3014592	6711409	149
150	22500	3375000	12.2474487	5.3132928	.006666667	150
151	22801	3442951	.2882057	.3250740	6622517	151
152	23104	3511808	.3288280	.3368033	6578947	152
153	23409	3581577	.3693169	.3484812	6535948	153
154	23716	3652264	.4096736	.3601084	6493506	154
155	24025	3723875	12.4498996	5.3716854	.006451613	155
156	24336	3796416	.4899960	.3832126	6410256	156
157	24649	3869893	.5299641	.3946907	6369427	157
158	24964	3944312	.5698051	.4061202	6329114	158
159	25281	4019679	.6095202	.4175015	6289308	159
160	25600	4096000	12.6491106	5.4288352	.006250000	160
161	25921	4173281	.6885775	.4401218	6211180	161
162	26244	4251528	.7279221	.4513618	6172840	162
163	26569	4330747	.7671453	.4625556	6134969	163
164	26896	4410944	.8062485	.4737037	6097561	164
165	27225	4492125	12.8452326	5.4848066	.006060606	165
166	27556	4574296	.8840987	.4958647	6024096	166
167	27889	4657463	.9228480	.5068784	5988024	167
168	28224	4741632	.9614814	.5178484	5952381	168
169	28561	4826809	13.0000000	.5287748	5917160	169
170	28900	4913000	13.0384048	5.5396583	.005882353	170
171	29241	5000211	.0766968	.5504991	5847953	171
172	29584	5088448	.1148770	.5612978	5813953	172
173	29929	5177717	.1529464	.5720546	5780347	173
174	30276	5268024	.1909060	.5827702	5747126	174
175	30625	5359375	13.2287566	5.5934447	.005714286	175
176	30976	5451776	.2664992	.6040787	5681818	176
177	31329	5545233	.3041347	.6146724	5649718	177
178	31684	5639752	.3416641	.6252263	5617978	178
179	32041	5735339	.3790882	.6357408	5586592	179

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Recipro-cals.	No.
180	32400	5832000	13.4164079	5.6462162	.005555556	180
181	32761	5929741	.4536240	.6566528	5524862	181
182	33124	6028568	.4907376	.6670511	5494505	182
183	33489	6128487	.5277493	.6774114	5464481	183
184	33856	6229504	.5646600	.6877340	5434783	184
185	34225	6331625	13.6014705	5.6980192	.005405405	185
186	34596	6434856	.6381817	.7082675	5376344	186
187	34969	6539203	.6747943	.7184791	5347594	187
188	35344	6644672	.7113092	.7286543	5319149	188
189	35721	6751269	.7477271	.7387936	5291005	189
190	36100	6859000	13.7840488	5. 71	.005263158	190
191	36481	6967871	.8202750	. 52	5235602	191
192	36864	7077888	.8564065	. 82	5208333	192
193	37249	7189057	.8924440	. 66	5181347	193
194	37636	7301384	.9283883	. 04	5154639	194
195	38025	7414875	13.9642400	5. 00	.005128205	195
196	38416	7529536	14.0000000	. 57	5102041	196
197	38809	7645373	.0356688	. 79	5076142	197
198	39204	7762392	.0712473	. 67	5050505	198
[illegible]	39601	7880599	.1067360	.8382725	5025126	199
200	40000	8000000	14.1421356	5.8480355	.005000000	200
201	40401	8120601	.1774469	.8577660	4975124	201
202	40804	8242408	.2126704	.8674643	4950495	202
203	41209	8365427	.2478068	.8771307	4926108	203
204	41616	8489664	.2828569	.8867653	4901961	204
205	42025	8615125	14.3178211	5.8963685	.004878049	205
206	42436	8741816	3527001	.9059406	4854369	206
207	42849	8869743	.3874946	.9154817	4830918	207
208	43264	8998912	.4222051	.9249921	4807692	208
209	43681	9129329	.4568323	.9344721	4784689	209
210	44100	9261000	14.4913767	5.9439220	.004761905	210
211	44521	9393931	.5258390	.9533418	4739336	211
212	44944	9528128	.5602198	.9627320	4716981	212
213	45369	9663597	.5945195	.9720926	4694836	213
214	45796	9800344	.6287388	.9814240	4672897	214
215	46225	9938375	14.6628783	5.9907264	.004651163	215
216	46656	10077696	.6969385	6.0000000	4629630	216
217	47089	10218313	.7309199	.0092450	4608295	217
218	47524	10360232	.7648231	.0184617	4587156	218
219	47961	10503459	.7986486	.0276502	4566210	219
220	48400	10648000	14.8323970	6.0368107	.004545455	220
221	48841	10793861	.8660687	.0459435	4524887	221
222	49284	10941048	.8996644	.0550489	4504505	222
223	49729	11089567	.9331845	.0641270	4484305	223
224	50176	11239424	.9666295	.0731779	4464286	224
225	50625	11390625	15.0000000	6.0822020	.004444444	225
226	51076	11543176	.0332964	.0911994	4424779	226
227	51529	11697083	.0665192	.1001702	4405286	227
228	51984	11852352	.0996689	.1091147	4385965	228
229	52441	12008989	.1327460	.1180332	4366812	229
230	52900	12167000	15.1657509	6.1269257	.004347826	230
231	53361	12326391	.1986842	.1357924	4329004	231
232	53824	12487168	.2315462	.1446337	4310345	232
233	54289	12649337	.2643375	.1534495	4291845	233
234	54756	12812904	.2970585	.1622401	4273504	234
235	55225	12977875	15.3297097	6.1710058	.004255319	235
236	55696	13144256	.3622915	.1797466	4237288	236
237	56169	13312053	.3948043	.1884628	4219409	237
238	56644	13481272	.4272486	.1971544	4201681	238
239	57121	13651919	.4596248	.2058218	4184100	239

240	57600	13824000	15.4919334	6.2144650	.004166667	240
241	58081	13997521	.5241747	.2230843	4149378	241
242	58564	14172488	.5563492	.2316797	4132231	242
243	59049	14348907	.5884573	.2402515	4115226	243
244	59536	14526784	.6204994	.2487998	4098361	244
245	60025	14706125	15.6524758	6.2573248	.004081633	245
246	60516	14886936	.6843871	.2658266	4065041	246
247	61009	15069223	.7162336	.2743054	4048583	247
248	61504	15252992	.7480157	.2827613	4032258	248
249	62001	15438249	.7797338	.2911946	4016064	249
250	62500	15625000	15.8113883	6.2996053	.004000000	250
251	63001	15813251	.8429795	.3079935	3984064	251
252	63504	16003008	.8745079	.3163596	3968254	252
253	64009	16194277	.9059737	.3247035	3952569	253
254	64516	16387064	.9373775	.3330256	3937008	254
255	65025	16581375	15.9687194	6.3413257	.003921569	255
256	65536	16777216	16.0000000	.3496042	3906250	256
257	66049	16974593	.0312195	.3578611	3891051	257
258	66564	17173512	.0623784	.3660968	3875969	258
259	67081	17373979	.0934769	.3743111	3861004	259
260	67600	17576000	16.1245155	6.3825043	.003846154	260
261	68121	17779581	.1554944	.3906765	3831418	261
262	68644	17984728	.1864141	.3988279	3816794	262
263	69169	18191447	.2172747	.4069585	3802281	263
264	69696	18399744	.2480768	.4150687	3787879	264
265	70225	18609625	16.2788206	6.4231583	.003773585	265
266	70756	18821096	.3095064	.4312276	3759398	266
267	71289	19034163	.3401346	.4392767	3745318	267
268	71824	19248832	.3707055	.4473057	3731343	268
269	72361	19465109	.4012195	.4553148	3717472	269
270	72900	19683000	16.4316767	6.4633041	.003703704	270
271	73441	19902511	.4620776	.4712736	3690037	271
272	73984	20123648	.4924225	.4792236	3676471	272
273	74529	20346417	.5227116	.4871541	3663004	273
274	75076	20570824	.5529454	.4950653	3649635	274
275	75625	20796875	16.5831240	6.5029572	.003636364	275
276	76176	21024576	.6132477	.5108300	3623188	276
277	76729	21253933	.6433170	.5186839	3610108	277
278	77284	21484952	.6733320	.5265189	3597122	278
279	77841	21717639	.7032931	.5343351	3584229	279
280	78400	21952000	16.7332005	6.5421326	.003571429	280
281	78961	22188041	.7630546	.5499116	3558719	281
282	79524	22425768	.7928556	.5576722	3546099	282
283	80089	22665187	.8226038	.5654144	3533569	283
284	80656	22906304	.8522995	.5731385	3521127	284
285	81225	23149125	16.8819430	6.5808443	.003508772	285
286	81796	23393656	.9115345	.5885323	3496503	286
287	82369	23639903	.9410743	.5962023	3484321	287
288	82944	23887872	.9705627	.6038545	3472222	288
289	83521	24137569	17.0000000	.6114890	3460208	289
290	84100	24389000	17.0293864	6.6191060	.003448276	290
291	84681	24642171	.0587221	.6267054	3436426	291
292	85264	24897088	.0880075	.6342874	3424658	292
293	85849	25153757	.1172428	.6418522	3412969	293
294	86436	25412184	.1464282	.6493998	3401361	294
295	87025	25672375	17.1755640	6.6569302	.003389831	295
296	87616	25934336	.2046505	.6644437	3378378	296
297	88209	26198073	.2336879	.6719403	3367003	297
298	88804	26463592	.2626765	.6794200	3355705	298
299	89401	26730899	.2916165	.6868831	3344482	299

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Recipro-cals.	No.
300	90000	27000000	17.3205081	6.6943295	.003333333	300
301	90601	27270901	.3493516	.7017593	3322259	301
302	91204	27543608	.3781472	.7091729	3311258	302
303	91809	27818127	.4068952	.7165700	3300330	303
304	92416	28094464	.4355958	.7239508	3289474	304
305	93025	28372625	17.4642492	6.7313155	.003278689	305
306	93636	28652616	.4928557	.7386641	3267974	306
307	94249	28934443	.5214155	.7459967	3257329	307
308	94864	29218112	.5499288	.7533134	3246753	308
309	95481	29503629	.5783958	.7606143	3236246	309
310	96100	29791000	17.6068169	6.7678995	.003225806	310
311	96721	30080231	.6351921	.7751690	3215434	311
312	97344	30371328	.6635217	.7824229	3205128	312
313	97969	30664297	.6918060	.7896613	3194888	313
314	98596	30959144	.7200451	.7968844	3184713	314
315	99225	31255875	17.7482393	6.8040921	.003174603	315
316	99856	31554496	.7763888	.8112847	3164557	316
317	100489	31855013	.8044938	.8184620	3154574	317
318	101124	32157432	.8325545	.8256242	3144654	318
319	101761	32461759	.8605711	.8327714	3134796	319
320	102400	32768000	17.8885438	6.8399037	.003125000	320
321	103041	33076161	.9164729	.8470213	3115265	321
322	103684	33386248	.9443584	.8541240	3105590	322
323	104329	33698267	.9722008	.8612120	3095975	323
324	104976	34012224	18.0000000	.8682855	3086420	324
325	105625	34328125	18.0277564	6.8753443	.003076923	325
326	106276	34645976	.0554701	.8823888	3067485	326
327	106929	34965783	.0831413	.8894188	3058104	327
328	107584	35287552	.1107703	.8964345	3048780	328
329	108241	35611289	.1383571	.9034359	3039514	329
330	108900	35937000	18.1659021	6.9104232	.003030303	330
331	109561	36264691	.1934054	.9173964	3021148	331
332	110224	36594368	.2208672	.9243556	3012048	332
333	110889	36926037	.2482876	.9313008	3003003	333
334	111556	37259704	.2756669	.9382321	2994012	334
335	112225	37595375	18.3030052	6.9451496	.002985075	335
336	112896	37933056	.3303028	.9520533	2976190	336
337	113569	38272753	.3575598	.9589434	2967359	337
338	114244	38614472	.3847763	.9658198	2958580	338
339	114921	38958219	.4119526	.9726826	2949853	339
340	115600	39304000	18.4390889	6.9795321	.002941176	340
341	116281	39651821	.4661853	.9863681	2932551	341
342	116964	40001688	.4932420	.9931906	2923977	342
343	117649	40353607	.5202592	7.0000000	2915452	343
344	118336	40707584	.5472370	.0067962	2906977	344
345	119025	41063625	18.5741756	7.0135791	.002898551	345
346	119716	41421736	.6010752	.0203490	2890173	346
347	120409	41781923	.6279360	.0271058	2881844	347
348	121104	42144192	.6547581	.0338497	2873563	348
349	121801	42508549	.6815417	.0405806	2865330	349
350	122500	42875000	18.7082869	7.0472987	.002857143	350
351	123201	43243551	.7349940	.0540041	2849003	351
352	123904	43614208	.7616630	.0606967	2840909	352
353	124609	43986977	.7882942	.0673767	2832861	353
354	125316	44361864	.8148877	.0740440	2824859	354
355	126025	44738875	18.8414437	7.0806988	.002816901	355
356	126736	45118016	.8679623	.0873411	2808989	356
357	127449	45499293	.8944436	.0939709	2801120	357
358	128164	45882712	.9208879	.1005885	2793296	358
359	128881	46268279	.9472953	.1071937	2785515	359

TABLE XXI.—SQUARES, CUBES, SQUARE ROOTS,

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.	No.
360	129600	46656000	18.9736660	7.1137866	.002777778	360
361	130321	47045881	19.0000000	.1203674	2770083	361
362	131044	47437928	.0262976	.1269360	2762431	362
363	131769	47832147	.0525589	.1334925	2754821	363
364	132496	48228544	.0787840	.1400370	2747253	364
365	133225	48627125	19.1049732	7.1465695	.002739726	365
366	133956	49027896	.1311265	.1530901	2732240	366
367	134689	49430863	.1572441	.1595988	2724796	367
368	135424	49836032	.1833261	.1660957	2717391	368
369	136161	50243409	.2093727	.1725809	2710027	369
370	136900	50653000	19.2353841	7.1790544	.002702703	370
371	137641	51064811	.2613603	.1855162	2695418	371
372	138384	51478848	.2873015	.1919663	2688172	372
373	139129	51895117	.3132079	.1984050	2680965	373
374	139876	52313624	.3390796	.2048322	2673797	374
375	140625	52734375	19.3649167	7.2112479	.002666667	375
376	141376	53157376	.3907194	.2176522	2659574	376
377	142129	53582633	.4164878	.2240450	2652520	377
378	142884	54010152	.4422221	.2304268	2645503	378
379	143641	54439939	.4679223	.2367972	2638522	379
380	144400	54872000	19.4935887	7.2431565	.002631579	380
381	145161	55306341	.5192213	.2495045	2624672	381
382	145924	55742968	.5448203	.2558415	2617801	382
383	146689	56181887	.5703858	.2621675	2610966	383
384	147456	56623104	.5959179	.2684824	2604167	384
385	148225	57066625	19.6214169	7.2747864	.002597403	385
386	148996	57512456	.6468827	.2810794	2590674	386
387	149769	57960603	.6723156	.2873617	2583979	387
388	150544	58411072	.6977156	.2936330	2577320	388
389	151321	58863869	.7230829	.2998936	2570694	389
390	152100	59319000	19.7484177	7.3061436	.002564103	390
391	152881	59776471	.7737199	.3123828	2557545	391
392	153664	60236288	.7989899	.3186114	2551020	392
393	154449	60698457	.8242276	.3248295	2544529	393
394	155236	61162984	.8494332	.3310369	2538071	394
395	156025	61629875	19.8746069	7.3372339	.002531646	395
396	156816	62099136	.8997487	.3434205	2525253	396
397	157609	62570773	.9248588	.3495966	2518892	397
398	158404	63044792	.9499373	.3557624	2512563	398
399	159201	63521199	.9749844	.3619178	2506266	399
400	160000	64000000	20.0000000	7.3680630	.002500000	400
401	160801	64481201	.0249844	.3741979	2493766	401
402	161604	64964808	.0499377	.3803227	2487562	402
403	162409	65450827	.0748599	.3864373	2481390	403
404	163216	65939264	.0997512	.3925418	2475248	404
405	164025	66430125	20.1246118	7.3986363	.002469136	405
406	164836	66923416	.1494417	.4047206	2463054	406
407	165649	67419143	.1742410	.4107950	2457002	407
408	166464	67917312	.1990099	.4168595	2450980	408
409	167281	68417929	.2237484	.4229142	2444988	409
410	168100	68921000	20.2484567	7.4289589	.002439024	410
411	168921	69426531	.2731349	.4349938	2433090	411
412	169744	69934528	.2977831	.4410189	2427184	412
413	170569	70444997	.3224014	.4470342	2421308	413
414	171396	70957944	.3469899	.4530399	2415459	414
415	172225	71473375	20.3715488	7.4590359	.002409639	415
416	173056	71991296	.3960781	.4650223	2403846	416
417	173889	72511713	.4205779	.4709991	2398082	417
418	174724	73034632	.4450483	.4769664	2392344	418
419	175561	73560059	.4694895	.4829242	2386635	419

420	176400	74088000	20.4939015	7.4888724	.002380952	420
421	177241	74618461	.5182845	.4948113	2375297	421
422	178084	75151448	.5426386	.5007406	2369668	422
423	178929	75686967	.5669638	.5066607	2364066	423
424	179776	76225024	.5912603	.5125715	2358491	424
425	180625	76765625	20.6155281	7.5184730	.002352941	425
426	181476	77308776	.6397674	.5243652	2347418	426
427	182329	77854483	.6639783	.5302482	2341920	427
428	183184	78402752	.6881609	.5361221	2336449	428
429	184041	78953589	.7123152	.5419867	2331002	429
430	184900	79507000	20.7364414	7.5478423	.002325581	430
431	185761	80062991	.7605395	.5536888	2320186	431
432	186624	80621568	.7846097	.5595263	2314815	432
433	187489	81182737	.8086520	.5653548	2309469	433
434	188356	81746504	.8326667	.5711743	2304147	434
435	189225	82312875	20.8566536	7.5769849	.002298851	435
436	190096	82881856	.8806130	.5827865	2293578	436
437	190969	83453453	.9045450	.5885793	2288330	437
438	191844	84027672	.9284495	.5943633	2283105	438
439	192721	84604519	.9523268	.6001385	2277904	439
440	193600	85184000	20.9761770	7.6059049	.002272727	440
441	194481	85766121	21.0000000	.6116626	2267574	441
442	195364	86350888	.0237960	.6174116	2262443	442
443	196249	86938307	.0475652	.6231519	2257336	443
444	197136	87528384	.0713075	.6288837	2252252	444
445	198025	88121125	21.0950231	7.6346067	.002247191	445
446	198916	88716536	.1187121	.6403213	2242152	446
447	199809	89314623	.1423745	.6460272	2237136	447
448	200704	89915392	.1660105	.6517247	2232143	448
449	201601	90518849	.1896201	.6574138	2227171	449
450	202500	91125000	21.2132034	7.6630943	.002222222	450
451	203401	91733851	.2367606	.6687665	2217295	451
452	204304	92345408	.2602916	.6744303	2212389	452
453	205209	92959677	.2837967	.6800857	2207506	453
454	206116	93576664	.3072758	.6857328	2202643	454
455	207025	94196375	21.3307290	7.6913717	.002197802	455
456	207936	94818816	.3541565	.6970023	2192982	456
457	208849	95443993	.3775583	.7026246	2188184	457
458	209764	96071912	.4009346	.7082388	2183406	458
459	210681	96702579	.4242853	.7138448	2178649	459
460	211600	97336000	21.4476106	7.7194426	.002173913	460
461	212521	97972181	.4709106	.7250325	2169197	461
462	213444	98611128	.4941853	.7306141	2164502	462
463	214369	99252847	.5174348	.7361877	2159827	463
464	215296	99897344	.5406592	.7417532	2155172	464
465	216225	100544625	21.5638587	7.7473109	.002150538	465
466	217156	101194696	.5870331	.7528606	2145923	466
467	218089	101847563	.6101828	.7584023	2141328	467
468	219024	102503232	.6333077	.7639361	2136752	468
469	219961	103161709	.6564078	.7694620	2132196	469
470	220900	103823000	21.6794834	7.7749801	.002127660	470
471	221841	104487111	.7025344	.7804904	2123142	471
472	222784	105154048	.7255610	.7859928	2118644	472
473	223729	105823817	.7485632	.7914875	2114165	473
474	224676	106496424	.7715411	.7969745	2109705	474
475	225625	107171875	21.7944947	7.8024538	.002105263	475
476	226576	107850176	.8174242	.8079254	2100840	476
477	227529	108531333	.8403297	.8133892	2096436	477
478	228484	109215352	.8632111	.8188456	2092050	478
479	229441	109902239	.8860686	.8242942	2087683	479

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.	No.
480	230400	110592000	21.9089023	7.8297353	.002083333	480
481	231361	111284641	.9317122	.8351688	2079002	481
482	232324	111980168	.9544984	.8405949	2074689	482
483	233289	112678587	.9772610	.8460134	2070393	483
484	234256	113379904	22.0000000	.8514244	2066116	484
485	235225	114084125	22.0227155	7.8568281	.002061856	485
486	236196	114791256	.0454077	.8622242	2057613	486
487	237169	115501303	.0680765	.8676130	2053388	487
488	238144	116214272	.0907220	.8729944	2049180	488
489	239121	116930169	.1133444	.8783684	2044990	489
490	240100	117649000	22.1359436	7.8837352	.002040816	490
491	241081	118370771	.1585198	.8890946	2036660	491
492	242064	119095488	.1810730	.8944468	2032520	492
493	243049	119823157	.2036033	.8997917	2028398	493
494	244036	120553784	.2261108	.9051294	2024291	494
495	245025	121287375	22.2485955	7.9104599	.002020202	495
496	246016	122023936	.2710575	.9157832	2016129	496
497	247009	122763473	.2934968	.9210994	2012072	497
498	248004	123505992	.3159136	.9264085	2008032	498
499	249001	124251499	.3383079	.9317104	2004008	499
500	250000	125000000	22.3606798	7.9370053	.002000000	500
501	251001	125751501	.3830293	.9422931	1996008	501
502	252004	126506008	.4053565	.9475739	1992032	502
503	253009	127263527	.4276615	.9528477	1988072	503
504	254016	128024064	.4499443	.9581144	1984127	504
505	255025	128787625	22.4722051	7.9633743	.001980198	505
506	256036	129554216	.4944438	.9686271	1976285	506
507	257049	130323843	.5166605	.9738731	1972387	507
508	258064	131096512	.5388553	.9791122	1968504	508
509	259081	131872229	.5610283	.9843444	1964637	509
510	260100	132651000	22.5831796	7.9895697	.001960784	510
511	261121	133432831	.6053091	.9947883	1956947	511
512	262144	134217728	.6274170	8.0000000	1953125	512
513	263169	135005697	.6495033	.0052049	1949318	513
514	264196	135796744	.6715681	.0104032	1945525	514
515	265225	136590875	22.6936114	8.0155946	.001941748	515
516	266256	137388096	.7156334	.0207794	1937984	516
517	267289	138188413	.7376340	.0259574	1934236	517
518	268324	138991832	.7596134	.0311287	1930502	518
519	269361	139798359	.7815715	.0362935	1926782	519
520	270400	140608000	22.8035085	8.0414515	.001923077	520
521	271441	141420761	.8254244	.0466030	1919386	521
522	272484	142236648	.8473193	.0517479	1915709	522
523	273529	143055667	.8691933	.0568862	1912046	523
524	274576	143877824	.8910463	.0620180	1908397	524
525	275625	144703125	22.9128785	8.0671432	.001904762	525
526	276676	145531576	.9346899	.0722620	1901141	526
527	277729	146363183	.9564806	.0773743	1897533	527
528	278784	147197952	.9782506	.0824800	1893939	528
529	279841	148035889	23.0000000	.0875794	1890359	529
530	280900	148877000	23.0217289	8.0926723	.001886792	530
531	281961	149721291	.0434372	.0977589	1883239	531
532	283024	150568768	.0651252	.1028390	1879699	532
533	284089	151419437	.0867928	.1079128	1876173	533
534	285156	152273304	.1084400	.1129803	1872659	534
535	286225	153130375	23.1300670	8.1180414	.001869159	535
536	287296	153990656	.1516738	.1230962	1865672	536
537	288369	154854153	.1732605	.1281447	1862197	537
538	289444	155720872	.1948270	.1331870	1858736	538
539	290521	156590819	.2163735	.1382230	1855288	539

Cube Roots.	Reciprocals.	No.
8.1432529	.001851852	540
.1482765	1848429	541
.1532939	1845018	542
.1583051	1841621	543
.1633102	1838235	544
8.1683092	.001834862	545
.1733020	1831502	546
.1782888	1828154	547
.1832695	1824818	548
.1882441	1821494	549
8.1932127	.001818182	550
.1981753	1814882	551
.2031319	1811594	552
.2080825	1808318	553
.2130271	1805054	554
8.2179657	.001801802	555
.2228985	1798561	556
.2278254	1795332	557
.2327463	1792115	558
.2376614	1788909	559
8.2425706	.001785714	560
.2474740	1782531	561
.2523715	1779359	562
.2572633	1776199	563
.2621492	1773050	564
8.2670294	.001769912	565
.2719039	1766784	566
.2767726	1763668	567
.2816355	1760563	568
.2864928	1757469	569
8.2913444	.001754386	570
.2961903	1751313	571
.3010304	1748252	572
.3058651	1745201	573
.3106941	1742160	574
8.3155175	.001739130	575
.3203353	1736111	576
.3251475	1733102	577
.3299542	1730104	578
.3347553	1727116	579
8.3395509	.001724138	580
.3443410	1721170	581
.3491256	1718213	582
.3539047	1715266	583
.3586784	1712329	584
8.3634466	.001709402	585
.3682095	1706485	586
.3729668	1703578	587
.3777188	1700680	588
.3824653	1697793	589
8.3872065	.001694915	590
.3919423	1692047	591
.3966729	1689189	592
.4013981	1686341	593
.4061180	1683502	594
8.4108326	.001680672	595
.4155419	1677852	596
.4202460	1675042	597
.4249448	1672241	598
.4296383	1669449	599

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.	No.
600	360000	216000000	24.4948974	8.4343267	.001666667	600
601	361201	217081801	.5153013	.4390098	1663894	601
602	362404	218167208	.5356883	.4436877	1661130	602
603	363609	219256227	.5560583	.4483605	1658375	603
604	364816	220348864	.5764115	.4530281	1655629	604
605	366025	221445125	24.5967478	8.4576906	.001652893	605
606	367236	222545016	.6170673	.4623479	1650165	606
607	368449	223648543	.6373700	.4670001	1647446	607
608	369664	224755712	.6576560	.4716471	1644737	608
609	370881	225866529	.6779254	.4762892	1642036	609
610	372100	226981000	24.6981781	8.4809261	.001639344	610
611	373321	228099131	.7184142	.4855579	1636661	611
612	374544	229220928	.7386338	.4901848	1633987	612
613	375769	230346397	.7588368	.4948065	1631321	613
614	376996	231475544	.7790234	.4994233	1628664	614
615	378225	232608375	24.7991935	8.5040350	.001626016	615
616	379456	233744896	.8193473	.5086417	1623377	616
617	380689	234885113	.8394847	.5132435	1620746	617
618	381924	236029032	.8596058	.5178403	1618123	618
619	383161	237176659	.8797106	.5224321	1615509	619
620	384400	238328000	24.8997992	8.5270189	.001612903	620
621	385641	239483061	.9198716	.5316009	1610306	621
622	386884	240641848	.9399278	.5361780	1607717	622
623	388129	241804367	.9599679	.5407501	1605136	623
624	389376	242970624	.9799920	.5453173	1602564	624
625	390625	244140625	25.0000000	8.5498797	.001600000	625
626	391876	245314376	.0199920	.5544372	1597444	626
627	393129	246491883	.0399681	.5589899	1594896	627
628	394384	247673152	.0599282	.5635377	1592357	628
629	395641	248858189	.0798724	.5680807	1589825	[illegible]
630	396900	250047000	25.0998008	8.5726189	[illegible]02	630
631	398161	251239591	.1197134	.5771523	[illegible]86	631
632	399424	252435968	.1396102	.5816809	[illegible]78	632
633	400689	253636137	.1594913	.5862047	[illegible]79	633
634	401956	254840104	.1793566	.5907238	[illegible]87	634
635	403225	256047875	25.1992063	8.5952380	[illegible]03	635
636	404496	257259456	.2190404	.5997476	[illegible]27	636
637	405769	258474853	.2388589	.6042525	[illegible]59	637
638	407044	259694072	.2586619	.6087526	[illegible]98	638
639	408321	260917119	.2784493	.6132480	[illegible]45	639
640	409600	262144000	25.2982213	8.6177388	.001562500	640
641	410881	263374721	.3179778	.6222248	1560062	641
642	412164	264609288	.3377189	.6267063	1557632	642
643	413449	265847707	.3574447	.6311830	1555210	[illegible]
644	414736	267089984	.3771551	.6356551	1552795	[illegible]
645	416025	268336125	25.3968502	8.6401226	.001550388	[illegible]
646	417316	269586136	.4165301	.6445855	1547988	[illegible]
647	418609	270840023	.4361947	.6490437	1545595	[illegible]
648	419904	272097792	.4558441	.6534974	1543210	[illegible]
649	421201	273359449	.4754784	.6579465	1540832	649
650	422500	274625000	25.4950976	8.6623911	.001538462	650
651	423801	275894451	.5147016	.6668310	1536098	651
652	425104	277167808	.5342907	.6712665	1533742	652
653	426409	278445077	.5538647	.6756974	1531394	653
654	427716	279726264	.5734237	.6801237	1529052	654
655	429025	281011375	25.5929678	8.6845456	.001526718	655
656	430336	282300416	.6124969	.6889630	1524390	656
657	431649	283593393	.6320112	.6933759	1522070	657
658	432964	284890312	.6515107	.6977843	1519757	658
659	434281	286191179	.6709953	.7021882	1517451	659

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Recipro-cals.	No.
660	435600	287496000	25.6904652	8.7065877	.001515152	[illegible]
661	436921	288804781	.7099203	.7109827	1512859	661
662	438244	290117528	.7293607	.7153734	1510574	662
663	439569	291434247	.7487864	.7197596	1508296	663
664	440896	292754944	.7681975	.7241414	1506024	664
665	442225	294079625	25.7875939	8.7285187	.001503759	665
666	443556	295408296	.8069758	.7328918	1501502	666
667	444889	296740963	.8263431	.7372604	1499250	667
668	446224	298077632	.8456960	.7416246	1497006	668
669	447561	299418309	.8650343	.7459846	1494768	669
670	448900	300763000	25.8843582	8.7503401	.001492537	670
671	450241	302111711	.9036677	.7546913	1490313	671
672	451584	303464448	.9229628	.7590383	1488095	672
673	452929	304821217	.9422435	.7633809	1485884	673
674	454276	306182024	.9615100	.7677192	1483680	674
675	455625	307546875	25.9807621	8.7720532	.001481481	675
676	456976	308915776	26.0000000	.7763830	1479290	676
677	458329	310288733	.0192237	.7807084	1477105	677
678	459684	311665752	.0384331	.7850296	1474926	678
679	461041	313046839	.0576284	.7893466	1472754	679
680	462400	314432000	26.0768096	8.7936593	88	680
681	463761	315821241	.0959767	.7979679	29	681
682	465124	317214568	.1151297	.8022721	76	682
683	466489	318611987	.1342687	.8065722	29	683
684	467856	320013504	.1533937	.8108681	88	684
685	469225	321419125	26.1725047	8.8151598	54	685
686	470596	322828856	.1916017	.8194474	26	686
687	471969	324242703	.2106848	.8237307	04	687
688	473344	325660672	.2297541	.8280099	88	688
689	474721	327082769	.2488095	.8322850	1451379	689
690	476100	328509000	26.2678511	8.8365559	.001449275	690
691	477481	329939371	.2868789	.8408227	1447178	691
692	478864	331373888	.3058929	.8450854	1445087	692
693	480249	332812557	.3248932	.8493440	1443001	693
694	481636	334255384	.3438797	.8535985	1440922	694
695	483025	335702375	26.3628527	8.8578489	.001438849	695
696	484416	337153536	.3818119	.8620952	1436782	696
697	485809	338608873	.4007576	.8663375	1434720	697
698	487204	340068392	.4196896	.8705757	1432665	698
699	488601	341532099	.4386081	.8748099	1430615	699
700	490000	343000000	26.4575131	8.8790400	.001428571	700
701	491401	344472101	.4764046	.8832661	1426534	701
702	492804	345948408	.4952826	.8874882	1424501	702
703	494209	347428927	.5141472	.8917063	1422475	703
704	495616	348913664	.5329983	.8959204	1420455	704
705	497025	350402625	26.5518361	8.9001304	.001418440	705
706	498436	351895816	.5706605	.9043366	1416431	706
707	499849	353393243	.5894716	.9085387	1414427	707
708	501264	354894912	.6082694	.9127369	1412429	708
709	502681	356400829	.6270539	.9169311	1410437	709
710	504100	357911000	26.6458252	8.9211214	.001408451	710
711	505521	359425431	.6645833	.9253078	1406470	711
712	506944	360944128	.6833281	.9294902	1404494	712
713	508369	362467097	.7020598	.9336687	1402525	713
714	509796	363994344	.7207784	.9378433	1400560	714
715	511225	365525875	26.7394839	8.9420140	.001398601	715
716	512656	367061696	.7581763	.9461809	1396648	716
717	514089	368601813	.7768557	.9503438	1394700	717
718	515524	370146232	.7955220	.9545029	1392758	718
719	516961	371694959	.8141754	.9586581	1390821	719

720	518400	373248000	26.8328157	8.9628095	.001388889	720
721	519841	374805361	.8514432	.9669570	1386963	721
722	521284	376367048	.8700577	.9711007	1385042	722
723	522729	377933067	.8886593	.9752406	1383126	723
724	524176	379503424	.9072481	.9793766	1381215	724
725	525625	381078125	26.9258240	8.9835089	.001379310	725
726	527076	382657176	.9443872	.9876373	1377410	726
727	528529	384240583	.9629375	.9917620	1375516	727
728	529984	385828352	.9814751	.9958829	1373626	728
729	531441	387420489	27.0000000	9.0000000	1371742	729
730	532900	389017000	27.0185122	9.0041134	.001369863	730
731	534361	390617891	.0370117	.0082229	1367989	731
732	535824	392223168	.0554985	.0123288	1366120	732
733	537289	393832837	.0739727	.0164309	1364256	733
734	538756	395446904	.0924344	.0205293	1362398	734
735	540225	397065375	27.1108834	9.0246239	.001360544	735
736	541696	398688256	.1293199	.0287149	1358696	736
737	543169	400315553	.1477439	.0328021	1356852	737
738	544644	401947272	.1661554	.0368857	1355014	738
739	546121	403583419	.1845544	.0409655	1353180	739
740	547600	405224000	27.2029410	9.0450417	.001351351	740
741	549081	406869021	.2213152	.0491142	1349528	741
742	550564	408518488	.2396769	.0531831	1347709	742
743	552049	410172407	.2580263	.0572482	1345895	743
744	553536	411830784	.2763634	.0613098	1344086	744
745	555025	413493625	27.2946881	9.0653677	.001342282	745
746	556516	415160936	.3130006	.0694220	1340483	746
747	558009	416832723	.3313007	.0734726	1338688	747
748	559504	418508992	.3495887	.0775197	1336898	748
[illegible]	561001	420189749	.3678644	.0815631	1335113	749
750	562500	421875000	27.3861279	9.0856030	.001333333	750
751	564001	423564751	.4043792	.0896392	1331558	751
752	565504	425259008	.4226184	.0936719	1329787	752
753	567009	426957777	.4408455	.0977010	1328021	753
754	568516	428661064	.4590604	.1017265	1326260	754
755	570025	430368875	27.4772633	9.1057485	.001324503	755
756	571536	432081216	.4954542	.1097669	1322751	756
757	573049	433798093	.5136330	.1137818	1321004	757
758	574564	435519512	.5317998	.1177931	1319261	758
[illegible]	576081	437245479	.5499546	.1218010	1317523	759
760	00	438976000	27.5680975	9.1258053	.001315789	760
761	21	440711081	.5862284	.1298061	1314060	761
762	44	442450728	.6043475	.1338034	1312336	762
763	69	444194947	.6224546	.1377971	1310616	763
764	96	445943744	.6405499	.1417874	1308901	764
765	25	447697125	27.6586334	9.1457742	.001307190	765
766	56	449455096	.6767050	.1497576	1305483	766
767	89	451217663	.6947648	.1537375	1303781	767
768	24	452984832	.7128129	.1577139	1302083	768
[illegible]	61	454756609	.7308492	.1616869	1300390	769
770	592900	456533000	27.7488739	9.1656565	.001298701	770
771	594441	458314011	.7668868	.1696225	1297017	771
772	595984	460099648	.7848880	.1735852	1295337	772
773	597529	461889917	.8028775	.1775445	1293661	773
774	599076	463684824	.8208555	.1815003	1291990	774
775	600625	465484375	27.8388218	9.1854527	.001290323	775
776	602176	467288576	.8567766	.1894018	1288660	776
777	603729	469097433	.8747197	.1933474	1287001	777
778	605284	470910952	.8926514	.1972897	1285347	778
779	606841	472729139	.9105715	.2012286	1283697	779

780	608400	474552000	27.9284801	9.2051641	.001282051	780
781	609961	476379541	9463772	.2090962	1280410	781
782	611524	478211768	.9642629	.2130250	1278772	782
783	613089	480048687	.9821372	.2169505	1277139	783
784	614656	481890304	28.0000000	.2208726	1275510	784
785	616225	483736625	28.0178515	9.2247914	.001273885	785
786	617796	485587656	.0356915	.2287068	1272265	786
787	619369	487443403	.0535203	.2326189	1270648	787
788	620944	489303872	.0713377	.2365277	1269036	788
789	622521	491169069	.0891438	.2404333	1267427	789
790	624100	493039000	28.1069386	9.2443355	.001265823	790
791	625681	494913671	.1247222	.2482344	1264223	791
792	627264	496793088	.1424946	.2521300	1262626	792
793	628849	498677257	.1602557	.2560224	1261034	793
794	630436	500566184	.1780056	.2599114	1259446	794
795	632025	502459875	28.1957444	9.2637973	.001257862	795
796	633616	504358336	.2134720	.2676798	1256281	796
797	635209	506261573	.2311884	.2715592	1254705	797
798	636804	508169592	.2488938	.2754352	1253133	798
799	638401	510082399	.2665881	.2793081	1251564	799
800	640000	512000000	28.2842712	9.2831777	.[illegible]00	800
801	641601	513922401	.3019434	.2870440	[illegible]39	801
802	[illegible]04	515849608	.3196045	.2909072	[illegible]83	802
803	[illegible]09	517781627	.3372546	.2947671	[illegible]30	803
804	[illegible]16	519718464	.3548938	.2986239	[illegible]81	804
805	[illegible]25	521660125	28.3725219	9.3024775	.[illegible]36	805
806	[illegible]36	523606616	.3901391	.3063278	[illegible]95	806
807	[illegible]49	525557943	.4077454	.3101750	[illegible]57	807
808	[illegible]64	527514112	.4253408	.3140190	[illegible]24	808
809	[illegible]81	529475129	.4429253	.3178599	[illegible]94	809
810	656100	531441000	28.4604989	9.3216975	.001234568	810
811	657721	533411731	.4780617	.3255320	1233046	811
812	659344	535387328	.4956137	.3293634	1231527	812
813	660969	537367797	.5131549	.3331916	1230012	813
814	662596	539353144	.5306852	.3370167	1228501	814
815	664225	541343375	28.5482048	9.3408386	.001226994	815
816	665856	543338496	.5657137	.3446575	1225490	816
817	667489	545338513	.5832119	.3484731	1223990	817
818	669124	547343432	.6006993	.3522857	1222494	818
819	670761	549353259	.6181760	.3560952	1221001	819
820	672400	551368000	28.6356421	9.3599016	.001219512	820
821	674041	553387661	.6530976	.3637049	1218027	821
822	675684	555412248	.6705424	.3675051	1216545	822
823	677329	557441767	.6879766	.3713022	1215067	823
824	678976	559476224	.7054002	.3750963	1213592	824
825	680625	561515625	28.7228132	9.3788873	.001212121	825
826	682276	563559976	.7402157	.3826752	1210654	826
827	683929	565609283	.7576077	.3864600	1209190	827
828	685584	567663552	.7749891	.3902419	1207729	828
829	687241	569722789	.7923601	.3940206	1206273	829
830	688900	571787000	28.8097206	9.3977964	.001204819	830
831	690561	573856191	.8270706	.4015691	1203369	831
832	692224	575930368	.8444102	.4053387	1201923	832
833	693889	578009537	.8617394	.4091054	1200480	833
834	695556	580093704	.8790582	.4128690	1199041	834
835	697225	582182875	28.8963666	9.4166297	.001197605	835
836	698896	584277056	.9136646	.4203873	1196172	836
837	700569	586376253	.9309523	.4241420	1194743	837
838	702244	588480472	.9482297	.4278936	1193317	838
839	703921	590589719	.9654967	.4316423	1191895	839

840	705600	592704000	28.9827535	9.4353880	.001190476	840
841	707281	594823321	29.0000000	.4391307	1189061	841
842	708964	596947688	.0172363	.4428704	1187648	842
843	710649	599077107	.0344623	.4466072	1186240	843
844	712336	601211584	.0516781	.4503410	1184834	844
845	714025	603351125	29.0688837	9.4540719	.001183432	845
846	715716	605495736	.0860791	.4577999	1182033	846
847	717409	607645423	.1032644	.4615249	1180638	847
848	719104	609800192	.1204396	.4652470	1179245	848
849	720801	611960049	.1376046	.4689661	1177856	849
850	722500	614125000	29.1547595	9.4726824	.001176471	850
851	724201	616295051	.1719043	.4763957	1175088	851
852	725904	618470208	.1890390	.4801061	1173709	852
853	727609	620650477	.2061637	.4838136	1172333	853
854	729316	622835864	.2232784	.4875182	1170960	854
855	731025	625026375	29.2403830	9.4912200	.001169591	855
856	732736	627222016	.2574777	.4949188	1168224	856
857	734449	629422793	.2745623	.4986147	1166861	857
858	736164	631628712	.2916370	.5023078	1165501	858
859	737881	633839779	.3087018	.5059980	1164144	859
860	739600	636056000	29.3257566	9.5096854	.001162791	860
861	741321	638277381	.3428015	.5133699	1161440	861
862	743044	640503928	.3598365	.5170515	1160093	862
863	744769	642735647	.3768616	.5207303	1158749	[illegible]
864	746496	644972544	.3938769	.5244063	1157407	864
865	748225	647214625	29.4108823	9.5280794	.001156069	865
866	749956	649461896	.4278779	.5317497	1154734	866
867	751689	651714363	.4448637	.5354172	1153403	867
868	753424	653972032	.4618397	.5390818	1152074	868
869	755161	656234909	.4788059	.5427437	1150748	869
870	756900	00	29.4957624	9.5464027	.001149425	870
871	758641	11	.5127091	.5500589	1148106	871
872	760384	48	.5296461	.5537123	1146789	872
873	762129	17	.5465734	.5573630	1145475	873
874	763876	24	.5634910	.5610108	1144165	874
875	765625	75	29.5803989	9.5646559	.001142857	875
876	767376	76	.5972972	.5682982	1141553	876
877	769129	33	.6141858	.5719377	1140251	877
878	770884	52	.6310648	.5755745	1138952	878
879	772641	39	.6479342	.5792085	1137656	879
880	774400	681472000	29.6647939	9.5828397	.001136364	880
881	776161	683797841	.6816442	.5864682	1135074	881
882	777924	686128968	.6984848	.5900939	1133787	882
883	779689	688465387	.7153159	.5937169	1132503	883
884	781456	690807104	.7321375	.5973373	1131222	884
885	783225	693154125	29.7489496	9.6009548	.001129944	885
886	784996	695506456	.7657521	.6045696	1128668	886
887	786769	697864103	.7825452	.6081817	1127396	887
888	788544	700227072	.7993289	.6117911	1126126	888
889	790321	702595369	.8161030	.6153977	1124859	889
890	792100	704969000	29.8328678	9.6190017	.001123596	890
891	793881	707347971	.8496231	.6226030	1122334	891
892	795664	709732288	.8663690	.6262016	1121076	892
893	797449	712121957	.8831056	.6297975	1119821	893
894	799236	714516984	.8998328	.6333907	1118568	894
895	801025	716917375	29.9165506	9.6369812	.001117318	895
896	802816	719323136	.9332591	.6405690	1116071	896
897	804609	721734273	.9499583	.6441542	1114827	897
898	806404	724150792	.9666481	.6477367	1113586	898
899	808201	726572699	.9833287	.6513166	1112347	899

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Recipro-cals.	No.
900	810000	729000000	30.0000000	9.6548938	.001111111	900
901	811801	731432701	.0166620	.6584684	1109878	901
902	813604	733870808	.0333148	.6620403	1108647	902
903	815409	736314327	.0499584	.6656096	1107420	903
904	817216	738763264	.0665928	.6691762	1106195	904
905	819025	741217625	30.0832179	9.6727403	.001104972	905
906	820836	743677416	.0998339	.6763017	1103753	906
907	822649	746142643	.1164407	.6798604	1102536	907
908	824464	748613312	.1330383	.6834166	1101322	908
909	826281	751089429	.1496269	.6869701	1100110	909
910	828100	753571000	30.1662063	9.6905211	.001098901	910
911	21	756058031	.1827765	.6940694	1097695	911
912	44	758550528	.1993377	.6976151	1096491	[redacted]
913	69	761048497	.2158899	.7011583	1095290	913
914	96	763551944	.2324329	.7046989	1094092	914
915	25	766060875	30.2489669	9.7082369	.001092896	915
916	56	768575296	.2654919	.7117723	1091703	916
917	89	771095213	.2820079	.7153051	1090513	917
918	24	773620632	.2985148	.7188354	1089325	918
919	61	776151559	.3150128	.7223631	1088139	919
920	00	778688000	30.3315018	9.7258883	.001086957	[redacted]
921	41	781229961	.3479818	.7294109	1085776	921
922	84	783777448	.3644529	.7329309	1084599	922
923	29	786330467	.3809151	.7364484	1083424	923
924	76	788889024	.3973683	.7399634	1082251	924
925	25	791453125	30.4138127	9.7434758	.001081081	925
926	76	794022776	.4302481	.7469857	1079914	926
927	29	796597983	.4466747	.7504930	1078749	927
928	84	799178752	.4630924	.7539979	1077586	928
929	41	801765089	.4795013	.7575002	1076426	929
930	864900	804357000	30.4959014	9.7610001	.001075269	930
931	866761	806954491	.5122926	.7644974	1074114	931
932	868624	809557568	.5286750	.7679922	1072961	932
933	870489	812166237	.5450487	.7714845	1071811	933
934	872356	814780504	.5614136	.7749743	1070664	934
935	874225	817400375	30.5777697	9.7784616	.001069519	935
936	876096	820025856	.5941171	.7819466	1068376	936
937	877969	822656953	.6104557	.7854288	1067236	937
938	879844	825293672	.6267857	.7889087	1066098	938
939	881721	827936019	.6431069	.7923861	1064963	939
940	883600	830584000	30.6594194	9.7958611	.001063830	940
941	885481	833237621	.6757233	.7993336	1062699	941
942	887364	835896888	.6920185	.8028036	1061571	942
943	889249	838561807	.7083051	.8062711	1060445	943
944	891136	841232384	.7245830	.8097362	1059322	944
945	893025	843908625	30.7408523	9.8131989	.001058201	945
946	894916	846590536	.7571130	.8166591	1057082	946
947	896809	849278123	.7733651	.8201169	1055966	947
948	898704	851971392	.7896086	.8235723	1054852	948
949	900601	854670349	.8058436	.8270252	1053741	949
950	902500	857375000	30.8220700	9.8304757	.001052632	950
951	904401	860085351	.8382879	.8339238	1051525	951
952	906304	862801408	.8544972	.8373695	1050420	952
953	908209	865523177	.8706981	.8408127	1049318	953
[redacted]	910116	868250664	.8868904	.8442536	1048218	954
955	912025	870983875	30.9030743	9.8476920	.001047120	955
956	913936	873722816	.9192497	.8511280	1046025	956
957	915849	876467493	.9354166	.8545617	1044932	957
958	917764	879217912	.9515751	.8579929	1043841	958
959	919681	881974079	.9677251	.8614218	1042753	959

No.	Squares.	Cubes.	Sq R			
960	921600	884736000	30.9838668	9.8648483	.001041667	960
961	923521	887503681	31.0000000	.8682724	1040583	961
962	925444	890277128	.0161248	.8716941	1039501	962
963	927369	893056347	.0322413	.8751135	1038422	963
964	929296	895841344	.0483494	.8785305	1037344	964
965	931225	898632125	31.0644491	9.8819451	.001036269	965
966	933156	901428696	.0805405	.8853574	1035197	966
967	935089	904231063	.0966236	.8887673	1034126	967
968	937024	907039232	.1126984	.8921749	1033058	968
969	938961	909853209	.1287648	.8955801	1031992	969
970	940900	912673000	31.1448230	9.8989830	.001030928	970
971	942841	915498611	.1608729	.9023835	1029866	971
972	944784	918330048	.1769145	.9057817	1028807	972
973	946729	921167317	.1929479	.9091776	1027749	973
974	948676	924010424	.2089731	.9125712	1026694	974
975	950625	926859375	31.2249900	9.9159624	.001025641	975
976	952576	929714176	.2409987	.9193513	1024590	976
977	954529	932574833	.2569992	.9227379	1023541	977
978	956484	935441352	.2729915	9261222	1022495	978
979	958441	938313739	.2889757	9295042	1021450	979
980	960400	941192000	31.3049517	9.9328839	.001020408	980
981	962361	944076141	.3209195	.9362613	1019368	981
982	964324	946966168	.3368792	.9396363	1018330	982
983	966289	949862087	.3528308	.9430092	1017294	983
984	968256	952763904	.3687743	9463797	1016260	984
985	970225	955671625	31.3847097	9.9497479	.001015228	985
986	972196	958585256	.4006369	.9531138	1014199	986
987	974169	961504803	.4165561	.9564775	1013171	987
988	976144	964430272	.4324673	.9598389	1012146	988
989	978121	967361669	.4483704	.9631981	1011122	989
990	980100	970299000	31.4642654	9.9665549	.001010101	990
991	982081	973242271	.4801525	.9699095	1009082	991
992	984064	976191488	.4960315	.9732619	1008065	992
993	986049	979146657	.5119025	.9766120	1007049	993
994	988036	982107784	.5277655	.9799599	1006036	994
995	990025	985074875	31.5436206	9.9833055	.001005025	995
996	992016	988047936	.5594677	.9866488	1004016	996
997	994009	991026973	.5753068	.9899900	1003009	997
998	996004	994011992	.5911380	.9933289	1002004	998
999	998001	997002999	6069613	.9966656	1001001	999
1000	1000000	1000000000	31.6227766	10.0000000	.001000000	1000
1001	1002001	1003003001	.6385840	.0033322	0999001	1001
1002	1004004	1006012008	.6543836	.0066622	0998004	1002
1003	1006009	1009027027	.6701752	.0099899	0997009	1003
1004	1008016	1012048064	.6859590	.0133155	0996016	1004
1005	1010025	1015075125	31.7017349	10.0166389	.000995025	1005
1006	1012036	1018108216	.7175030	.0199601	0994036	1006
1007	1014049	1021147343	.7332633	.0232791	0993049	1007
1008	1016064	1024192512	.7490157	.0265958	0992063	1008
1009	1018081	1027243729	.7647603	.0299104	0991080	1009
1010	1020100	1030301000	31.7804972	10.0332228	.000990099	1010
1011	1022121	1033364331	.7962262	.0365330	0989120	1011
1012	1024144	1036433728	.8119474	.0398410	0988142	1012
1013	1026169	1039509197	.8276609	.0431469	0987167	1013
1014	1028196	1042590744	8433666	.0464506	0986193	1014
1015	1030225	1045678375	31.8590646	10.0497521	.000985222	1015
1016	1032256	1048772096	.8747549	0530514	0984252	1016
1017	1034289	1051871913	8904374	0563485	0983284	1017
1018	1036324	1054977832	.9061123	.0596435	0982318	1018
1019	1038361	1058089859	.9217794	0629364	0981354	1019

Gauge 4′ 8½″=4.7083

Frog No.	Frog Angle	Rad. of Turnout	Deg. of Turnout	Lead E.	Crotch No.	Crotch Angle	Crotch Lead	Frog No.
4	14°15′	150.67	38°46′	37.67	2.82	20°08′	26.84	4
4½	12 41	190.69	30 24	42.37	3.17	17 55	30.15	4½
5	11 25	235.42	24 31	47.08	3.53	16 08	33.46	5
5½	10 23	284.85	20 13	51.79	3.88	14 41	36.77	5½
6	9 32	339.00	16 58	56.50	4.24	13 28	40.09	6
6½	8 48	397.85	14 26	61.21	4.59	12 26	43.41	6½
7	8 10	461.42	12 27	65.92	4.94	11 33	46.73	7
7½	7 38	529.69	10 50	70.62	5.30	10 47	50.05	7½
8	7 09	602.67	9 31	75.33	5.65	10 07	53.37	8
8½	6 44	680.35	8 26	80.04	6.01	9 31	56.70	8½
9	6 22	762.75	7 31	84.75	6.36	8 59	60.02	9
9½	6 02	849.85	6 45	89.46	6.71	8 31	63.34	9½
10	5 43	941.67	6 05	94.17	7.07	8 06	66.67	10
10½	5 27	1038.19	5 31	98.88	7.42	7 43	69.99	10½
11	5 12	1139.42	5 02	103.58	7.77	7 22	73.32	11
11½	4 59	1245.35	4 36	108.29	8.13	7 02	76.65	11½
12	4 46	1356.00	4 14	113.00	8.48	6 45	79.97	12

Gauge 3′

Frog No.	Frog Angle	Rad. of Turnout	Deg. of Turnout	Lead E.	Crotch No.	Crotch Angle	Crotch Lead	Frog No.
4	14°15′	96.0	62°47′	24.	2.82	20°08′	17.10	4
4½	12 41	121.5	48 36	27.	3.17	17 55	19.21	4½
5	11 25	150.0	38 57	30.	3.53	16 08	21.32	5
5½	10 23	181.5	31 59	33.	3.88	14 41	23.43	5½
6	9 32	216.0	26 46	36.	4.24	13 28	25.54	6
6½	8 48	253.5	22 45	39.	4.59	12 26	27.66	6½
7	8 10	294.0	19 35	42.	4.94	11 33	29.77	7
7½	7 38	337.5	17 02	45.	5.30	10 47	31.89	7½
8	7 09	384.0	14 58	48.	5.65	10 07	34.01	8
8½	6 44	433.5	13 15	51.	6.01	9 31	36.12	8½
9	6 22	486.0	11 49	54.	6.36	8 59	38.24	9
9½	6 02	541.5	10 36	57.	6.71	8 31	40.36	9½
10	5 43	600.0	9 34	60.	7.07	8 06	42.48	10
10½	5 27	661.5	8 40	63.	7.42	7 43	44.60	10½
11	5 12	726.0	7 54	66.	7.77	7 22	46.72	11
11½	4 59	793.5	7 14	69.	8.13	7 02	48.84	11½
12	4 46	864.0	6 38	72.	8.48	6 45	50.96	12

Gauge 4′ 9″=4.75

Frog No.	Frog Angle	Rad. of Turnout	Deg. of Turnout	Lead E.	Crotch No.	Crotch Angle	Crotch Lead	Frog No.
4	14°15′	152.00	38°25′	38.00	2.82	20°08′	27.08	4
4½	12 41	192.38	30 08	42.75	3.17	17 55	30.41	4½
5	11 25	237.50	24 18	47.50	3.53	16 08	33.76	5
5½	10 23	287.38	20 02	52.25	3.88	14 41	37.10	5½
6	9 32	342.00	16 49	57.00	4.24	13 28	40.44	6
6½	8 48	401.38	14 19	61.75	4.59	12 26	43.79	6½
7	8 10	465.50	12 20	66.50	4.94	11 33	47.14	7
7½	7 38	534.38	10 44	71.25	5.30	10 47	50.49	7½
8	7 09	608.00	9 26	76.00	5.65	10 07	53.84	8
8½	6 44	686.38	8 21	80.75	6.01	9 31	57.20	8½
9	6 22	769.50	7 27	85.50	6.36	8 59	60.55	9
9½	6 02	857.38	6 41	90.25	6.71	8 31	63.90	9½
10	5 43	950.00	6 02	95.00	7.07	8 06	67.26	10
10½	5 27	1047.38	5 28	99.75	7.42	7 43	70.61	10½
11	5 12	1149.50	4 59	104.50	7.77	7 22	73.97	11
11½	4 59	1256.38	4 34	109.25	8.13	7 02	77.32	11½
12	4 46	1368.00	4 11	114.00	8.48	6 45	80.68	12

TABLE XXII. A.—A. R. E. A. SPLIT SWITCH TURNOUTS

	Properties of Frogs Thickness of Point = ½″					Switches Th. of Point = ¼″ Spread of Heel = 6¼″		Theoretical Leads				
Number of Frog	Angle of Frog	Theoretical Point to Toe	Theoretical Point to Heel	Spread at Toe	Spread at Heel	Actual Length of Rail	Switch Angle	Radius of Turnout Curve	Degree of Turnout Curve	Point of Switch to Theoretical Point of Frog	Closure Straight Rail	Closure Curved Rail
4	14°15′00″	3′ 2″	5′ 4″	.79′	1.32′	11′0″	2°36′19″	112.26	52°53′56″	37.05′	22.88′	23.29′
5	11 25 16	3 7	6 5	.71	1.28	11 0	2 36 19	183.22	31 40 24	42.77	28.19	28.55
6	9 31 38	4 0	7 0	.66	1.16	11 0	2 36 19	273.95	21 01 58	48.11	33.11	33.38
7	8 10 16	4 5	8 1	.63	1.15	16 6	1 44 11	364.88	15 47 19	61.94	41.02	41.24
8	7 09 10	4 9	8 9	.59	1.09	16 6	1 44 11	488.71	11 44 40	67.47	46.22	46.42
9	6 21 35	6 0	10 0	.67	1.11	16 6	1 44 11	616.27	9 18 27	72.24	49.74	49.92
9½	6 01 32	6 0	10 0	.63	1.05	16 6	1 44 11	699.97	8 11 33	74.90	52.40	52.58
10	5 43 29	6 0	10 6	.60	1.05	16 6	1 44 11	790.25	7 15 18	77.51	55.01	55.17
11	5 12 18	6 0	11 6	.54	1.05	22 0	1 18 08	940.21	6 05 48	92.06	64.06	64.20
12	4 46 19	6 5	12 1	.53	1.01	22 0	1 18 08	1136.34	5 02 38	97.25	68.83	68.96
15	3 49 06	7 8	14 10	.51	.99	33 0	0 52 05	1744.45	3 17 06	130.50	89.83	89.94
16	3 34 47	8 0	16 0	.50	1.00	33 0	0 52 05	2005.98	2 51 24	135.95	94.95	95.05
18	3 10 56	8 10	17 8	.49	.98	33 0	0 52 05	2587.66	2 12 52	146.38	104.54	104.61
20	2 51 51	9 8	19 4	.48	.97	33 0	0 52 05	3262.98	1 45 22	156.35	113.68	113.76
24	2 23 13	11 4	23 2	.47	.97	33 0	0 52 05	4932.77	1 09 42	175.09	130.66	130.77

TABLE XXII. B.—A. R. E. A. SPLIT SWITCH TURNOUTS

PRACTICAL LEADS

Number of Frog	Radius of Turnout Curve	Degree of Turnout Curve	Tangents: Next to Switch Rail	Tangents: Next to Frog	Point of Switch to Theoretical Point of Frog	Point of Switch to Actual Point of Frog	Closure of Straight Rail	Closure of Curved Rail	Coördinates of Curved Rail referred to Straight Rail with Origin at Point of Switch					
4	110.69′	53°42′24″	1.03′	0.00′	37.77′	37.94′	23.60′	24′	17.74′	0.97′	23.44′	1.67′	29.75′	2.79′
5	174.34	33 19 57	0.00	0.82	42.26	42.47	27.68	28	17.78	0.95	24.54	1.61	31.27	2.62
6	265.39	21 43 04	0.00	0.66	47.73	47.98	32.73	33	19.07	1.01	27.13	1.74	35.15	2.72
7	362.08	15 52 29	0.00	0.19	61.81	62.10	13.89 + 27	14.11 + 27	26.72	0.97	36.93	1.71	47.11	2.74
8	487.48	11 46 27	0.30	0.00	67.65	67.98	16.40 + 30	16.60 + 30	28.37	1.02	39.91	1.78	51.45	2.91
9	605.18	9 28 42	0.00	0.57	71.91	72.28	16.41 + 33	16.59 + 33	28.75	1.02	40.98	1.76	53.19	2.75
9½	695.45	8 14 45	0.76	0.00	75.32	75.71	25.82 + 27	26.00 + 27	30.31	1.06	43.35	1.82	56.37	2.83
10	790.25	7 15 18	0.00	0.00	77.51	77.98	27.00 + 28	27.17 + 28	30.28	1.06	44.05	1.84	57.81	2.85
11	922.65	6 12 47	2.99	0.00	93.85	94.31	32.85 + 33	2 × 33	40.74	1.08	56.47	1.84	72.19	2.87
12	1098.73	5 12 59	5.33	0.00	100.30	100.80	23.88 + 2 × 24	3 × 24	43.99	1.15	60.65	1.90	77.28	2.91
15	1743.80	3 17 10	0.09	0.00	130.56	131.19	29.89 + 2 × 30	3 × 30	55.49	1.01	77.98	1.78	100.45	2.84
16	1993.24	2 52 59	1.56	0.00	136.90	137.57	29.90 + 2 × 33	30.00 + 2 × 33	58.16	1.04	81.76	1.82	105.35	2.87
18	2546.31	2 14 31	0.00	1.08	145.76	146.51	25.93 + 3 × 26	4 × 26	58.73	1.04	84.46	1.82	110.10	2.86
20	3257.26	1 45 32	0.44	0.00	156.59	157.42	26.92 + 2 × 27 + 33	33.00 + 3 × 27	61.84	1.08	90.21	1.88	118.59	2.93
24	4886.16	1 10 21	2.43	0.00	176.22	177.22	32.89 + 3 × 33	4 × 33	67.82	1.27	100.21	1.97	132.59	3.00

TABLE XXIII.—VELOCITY HEIGHTS.

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03
1	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13
2	0.14	0.16	0.17	0.19	0.20	0.22	0.24	0.26	0.28	0.30
3	0.32	0.34	0.36	0.39	0.41	0.43	0.46	0.49	0.51	0.54
4	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.78	0.82	0.85
5	0.89	0.92	0.96	1.00	1.04	1.07	1.11	1.15	1.19	1.24
6	1.28	1.32	1.36	1.41	1.45	1.50	1.55	1.59	1.64	1.69
7	1.74	1.79	1.84	1.89	1.94	2.00	2.05	2.10	2.16	2.22
8	2.27	2.33	2.39	2.45	2.50	2.56	2.63	2.69	2.75	2.81
9	2.88	2.94	3.00	3.07	3.14	3.20	3.27	3.34	3.41	3.48
10	3.55	3.62	3.69	3.77	3.84	3.91	3.99	4.06	4.14	4.22
11	4.30	4.37	4.45	4.53	4.61	4.69	4.78	4.86	4.94	5.03
12	5.11	5.20	5.28	5.37	5.46	5.55	5.64	5.73	5.82	5.91
13	6.00	6.09	6.19	6.28	6.37	6.47	6.57	6.66	6.76	6.86
14	6.96	7.06	7.16	7.26	7.36	7.46	7.57	7.67	7.78	7.88
15	7.99	8.09	8.20	8.31	8.42	8.53	8.64	8.75	8.86	8.97
16	9.09	9.20	9.32	9.43	9.55	9.66	9.78	9.89	10.00	10.14
17	10.26	10.38	10.50	10.62	10.75	10.87	11.00	11.12	11.25	11.37
18	11.50	11.63	11.76	11.89	12.02	12.15	12.28	12.41	12.55	12.68
19	12.82	12.95	13.09	13.22	13.36	13.50	13.64	13.78	13.92	14.06
20	14.20	14.34	14.49	14.63	14.77	14.92	15.06	15.21	15.36	15.51
21	15.66	15.80	15.96	16.11	16.26	16.41	16.56	16.72	16.87	17.03
22	17.18	17.34	17.50	17.65	17.81	17.97	18.13	18.29	18.45	18.62
23	18.78	18.94	19.11	19.27	19.44	19.60	19.77	19.94	20.11	20.28
24	20.45	20.62	20.79	20.96	21.14	21.31	21.48	21.66	21.83	22.01
25	22.19	22.37	22.54	22.72	22.90	23.08	23.27	23.45	23.63	23.81
26	24.00	24.18	24.37	24.55	24.74	24.93	25.12	25.31	25.50	25.69
27	25.88	26.07	26.26	26.46	26.65	26.85	27.04	27.24	27.44	27.63
28	27.83	28.03	28.23	28.43	28.63	28.83	29.04	29.24	29.45	29.65
29	29.86	30.06	30.27	30.48	30.68	30.89	31.10	31.31	31.53	31.74
30	31.95	32.16	32.38	32.59	32.81	33.02	33.24	33.46	33.68	33.90
31	34.12	34.34	34.56	34.78	35.00	35.22	35.45	35.67	35.90	36.13
32	36.35	36.58	36.81	37.04	37.27	37.50	37.73	37.96	38.19	38.43
33	38.66	38.89	39.13	39.37	39.60	39.84	40.08	40.32	40.56	40.80
34	41.04	41.28	41.52	41.77	42.01	42.25	42.50	42.75	42.99	43.24
35	43.49	43.74	43.99	44.24	44.49	44.74	44.99	45.24	45.50	45.75
36	46.01	46.26	46.52	46.78	47.04	47.29	47.55	47.81	48.08	48.34
37	48.60	48.86	49.13	49.39	49.66	49.92	50.19	50.46	50.72	50.99
38	51.26	51.53	51.80	52.07	52.35	52.62	52.89	53.17	53.44	53.72
39	54.00	54.27	54.55	54.83	55.11	55.39	55.67	55.95	56.23	56.52
40	56.80	57.08	57.37	57.66	57.94	58.23	58.52	58.81	59.09	59.38
41	59.68	59.97	60.26	60.55	60.85	61.14	61.43	61.73	62.03	62.32
42	62.62	62.92	63.22	63.52	63.82	64.12	64.42	64.73	65.03	65.33
43	65.64	65.95	66.25	66.56	66.87	67.17	67.48	67.79	68.10	68.42
44	68.73	69.04	69.35	69.67	69.98	70.30	70.62	70.93	71.25	71.57
45	71.89	72.21	72.53	72.85	73.17	73.49	73.82	74.14	74.47	74.79
46	75.12	75.44	75.77	76.10	76.43	76.76	77.09	77.42	77.73	78.09
47	78.42	78.75	79.09	79.42	79.76	80.10	80.43	80.77	81.11	81.45
48	81.79	82.13	82.48	82.82	83.16	83.50	83.85	84.19	84.54	84.89
49	85.24	85.58	85.93	86.28	86.63	86.98	87.34	87.69	88.04	88.40
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9

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Table for solvin

Given Par

Parts	Hyp	Adj
Hyp & Angle	Given.	(Hyp)(Cos θ
Opp & Angle	(Opp)(Csc θ)	(Opp)(Cot θ
2 Sides	(Csc θ opp 1 side)(mat side)	Given
Hyp & 1 Side.	Sin θ Opp Given Side adj to this	
Adj & Angle.	(Adj)(Sec θ)	Given

.7	.8	.9
1.25	91.61	91.97
4.89	95.26	95.62
8.59	98.97	99.34
2.37	102.75	103.13
6.22	106.61	107.00
0.14	110.53	110.93
4.13	114.53	114.94
8.19	118.60	119.01
2.32	122.74	123.16
6.53	126.95	127.37
0.80	131.23	131.66
5.14	135.58	136.02
9.56	140.01	140.45
4.05	144.50	144.95
8.61	149.07	149.53
3.24	153.70	154.17
7.94	158.41	158.88
2.71	163.29	163.67
7.55	168.04	168.53
2.46	172.96	173.45
7.45	177.95	178.45
2.50	183.01	183.52
7.63	188.14	188.66
2.82	193.35	193.87
8.09	198.62	199.16
3.43	203.97	204.51
8.84	209.39	209.93
4.32	214.88	215.43
9.88	220.44	220.99
5.50	226.07	226.63
1.19	231.77	232.34
6.96	237.54	238.12
2.79	243.38	243.97
8.70	249.30	249.89
4.68	255.28	255.88
0.73	261.34	261.95
6.85	267.47	268.08
3.04	273.66	274.29
9.30	279.93	280.56
5.64	286.27	286.91
2.04	292.68	293.33
8.52	299.17	299.82
5.06	305.72	306.38
1.68	312.34	313.01
8.37	319.04	319.71
5.13	325.81	326.49
1.96	332.64	333.33
8.86	339.55	340.25
5.83	346.53	347.23
2.87	353.58	354.29
.7	.8	.9

370 W.35 St. Riverside [illegible] N.Y., N.Y.

TABL[redacted]ELOCITY HEIGHTS.

	.0	.1
0	0.00	0.00
1	0.04	0.04
2	0.14	0.16
3	0.32	0.34
4	0.57	0.60
5	0.89	0.92
6	1.28	1.32
7	1.74	1.79
8	2.27	2.33
9	2.88	2.94
10	3.55	3.62
11	4.30	4.37
12	5.11	5.20
13	6.00	6.09
14	6.96	7.06
15	7.99	8.09
16	9.09	9.20
17	10.26	10.38
18	11.50	11.63
19	12.82	12.95
20	14.20	14.34
21	15.66	15.80
22	17.18	17.34
23	18.78	18.94
24	20.45	20.62
25	22.19	22.37
26	24.00	24.18
27	25.88	26.07
28	27.83	28.03
29	29.86	30.06
30	31.95	32.16
31	34.12	34.34
32	36.35	36.58
33	38.66	38.89
34	41.04	41.28
35	43.49	43.74
36	46.01	46.26
37	48.60	48.86
38	51.26	51.53
39	54.00	54.27
40	56.80	57.08
41	59.68	59.97
42	62.62	62.92
43	65.64	65.95
44	68.73	69.04
45	71.89	72.21
46	75.12	75.44
47	78.42	78.75
48	81.79	82.13
49	85.24	85.58
	.0	.1

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...g right angled Triangles.

...ts to be Found.

	Opp	Angle θ	Opp Angle
)	(Hyp)(Sin θ)	Given	90° - θ
)	Given	Given	90° - θ
	Given	Tan θ Opp side = that side / other side	90° - θ
...n side = Given Side / Hypotenuse. ...θ = (Given Side)(Cot θ)			90° - θ
	Ad: Hipo θ)	Given	90° - θ

TABLE XXIII. — VELOCITY HEIGHTS.

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
50	88.75	89.11	89.46	89.82	90.18	90.53	90.89	91.25	91.61	91.97
51	92.34	92.70	93.06	93.42	93.79	94.15	94.52	94.89	95.26	95.62
52	95.99	96.36	96.73	97.10	97.47	97.85	98.22	98.59	98.97	99.34
53	99.72	100.10	100.47	100.85	101.23	101.61	101.99	102.37	102.75	103.13
54	103.52	103.90	104.29	104.67	105.06	105.44	105.83	106.22	106.61	107.00
55	107.39	107.78	108.17	108.56	108.96	109.35	109.74	110.14	110.53	110.93
56	111.33	111.73	112.12	112.52	112.92	113.32	113.73	114.13	114.53	114.94
57	115.34	115.74	116.15	116.56	116.96	117.37	117.78	118.19	118.60	119.01
58	119.42	119.83	120.25	120.66	121.07	121.49	121.91	122.32	122.74	123.16
59	123.58	123.99	124.41	124.84	125.26	125.68	126.10	126.53	126.95	127.37
60	127.80	128.23	128.65	129.08	129.51	129.94	130.37	130.80	131.23	131.66
61	132.10	132.53	132.96	133.40	133.83	134.27	134.71	135.14	135.58	136.02
62	136.46	136.90	137.34	137.79	138.23	138.67	139.12	139.56	140.01	140.45
63	140.90	141.35	141.80	142.24	142.69	143.14	143.60	144.05	144.50	144.95
64	145.41	145.86	146.32	146.77	147.23	147.69	148.15	148.61	149.07	149.53
65	149.99	150.45	150.91	151.38	151.84	152.30	152.77	153.24	153.70	154.17
66	154.64	155.11	155.58	156.05	156.52	156.99	157.46	157.94	158.41	158.88
67	159.36	159.84	160.31	160.79	161.27	161.75	162.23	162.71	163.29	163.67
68	164.15	164.64	165.12	165.60	166.09	166.57	167.06	167.55	168.04	168.53
69	169.02	169.51	170.00	170.49	170.98	171.47	171.97	172.46	172.96	173.45
70	173.95	174.45	174.95	175.44	175.94	176.44	176.94	177.45	177.95	178.45
71	178.96	179.46	179.97	180.47	180.98	181.48	181.99	182.50	183.01	183.52
72	184.03	184.54	185.06	185.57	186.08	186.60	187.11	187.63	188.14	188.66
73	189.18	189.70	190.22	190.74	191.26	191.78	192.30	192.82	193.35	193.87
74	194.40	194.92	195.45	195.98	196.51	197.03	197.56	198.09	198.62	199.16
75	199.69	200.22	200.75	201.29	201.82	202.36	202.90	203.43	203.97	204.51
76	205.05	205.59	206.13	206.67	207.21	207.75	208.30	208.84	209.39	209.93
77	210.48	211.03	211.57	212.12	212.67	213.22	213.77	214.32	214.88	215.43
78	215.98	216.54	217.09	217.65	218.20	218.76	219.32	219.88	220.44	220.99
79	221.56	222.12	222.68	223.24	223.80	224.37	224.93	225.50	226.07	226.63
80	227.20	227.77	228.34	228.91	229.48	230.05	230.62	231.19	231.77	232.34
81	232.92	233.49	234.07	234.64	235.22	235.80	236.38	236.96	237.54	238.12
82	238.70	239.28	239.87	240.45	241.04	241.62	242.21	242.79	243.38	243.97
83	244.56	245.15	245.74	246.33	246.92	247.51	248.11	248.70	249.30	249.89
84	250.49	251.08	251.68	252.28	252.88	253.48	254.08	254.68	255.28	255.88
85	256.49	257.09	257.70	258.30	258.91	259.51	260.12	260.73	261.34	261.95
86	262.56	263.17	263.78	264.39	265.01	265.62	266.23	266.85	267.47	268.08
87	268.70	269.32	269.94	270.56	271.18	271.80	272.42	273.04	273.66	274.29
88	274.91	275.54	276.16	276.79	277.42	278.04	278.67	279.30	279.93	280.56
89	281.20	281.83	282.46	283.09	283.73	284.36	285.00	285.64	286.27	286.91
90	287.55	288.19	288.83	289.47	290.11	290.75	291.40	292.04	292.68	293.33
91	293.98	294.62	295.27	295.92	296.57	297.21	297.86	298.52	299.17	299.82
92	300.47	301.13	301.78	302.43	303.09	303.75	304.40	305.06	305.72	306.38
93	307.04	307.70	308.36	309.02	309.69	310.35	311.01	311.68	312.34	313.01
94	313.68	314.35	315.01	315.68	316.35	317.02	317.70	318.37	319.04	319.71
95	320.39	321.06	321.74	322.41	323.09	323.77	324.45	325.13	325.81	326.49
96	327.17	327.85	328.53	329.22	329.90	330.58	331.27	331.96	332.64	333.33
97	334.02	334.71	335.40	336.09	336.78	337.47	338.16	338.86	339.55	340.25
98	340.94	341.64	342.34	343.03	343.73	344.43	345.13	345.83	346.53	347.23
99	347.94	348.64	349.34	350.05	350.75	351.46	352.17	352.87	353.58	354.29
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9

TABLE XXIV.—RISE PER MILE OF VARIOUS GRADES

Grade per Station	Rise per Mile	Grade per Station	Rise per Mile	Grade per Station	Rise per Mile	Grade per Station	Rise per Mile
.01	.528	.61	32.208	1.21	63.888	1.81	95.568
.02	1.056	.62	32.736	1.22	64.416	1.82	96.096
.03	1.584	.63	33.264	1.23	64.944	1.83	96.624
.04	2.112	.64	33.792	1.24	65.472	1.84	97.152
.05	2.640	.65	34.320	1.25	66.000	1.85	97.680
.06	3.168	.66	34.848	1.26	66.528	1.86	98.208
.07	3.696	.67	35.376	1.27	67.056	1.87	98.736
.08	4.224	.68	35.904	1.28	67.584	1.88	99.264
.09	4.752	.69	36.432	1.29	68.112	1.89	99.792
.10	5.280	.70	36.960	1.30	68.640	1.90	100.320
.11	5.808	.71	37.488	1.31	69.168	1.91	100.848
.12	6.336	.72	38.016	1.32	69.696	1.92	101.376
.13	6.864	.73	38.544	1.33	70.224	1.93	101.904
.14	7.392	.74	39.072	1.34	70.752	1.94	102.432
.15	7.920	.75	39.600	1.35	71.280	1.95	102.960
.16	8.448	.76	40.128	1.36	71.808	1.96	103.488
.17	8.976	.77	40.656	1.37	72.336	1.97	104.016
.18	9.504	.78	41.184	1.38	72.864	1.98	104.544
.19	10.032	.79	41.712	1.39	73.392	1.99	105.072
.20	10.560	.80	42.240	1.40	73.920	2.00	105.600
.21	11.088	.81	42.768	1.41	74.448	2.10	110.880
.22	11.616	.82	43.296	1.42	74.976	2.20	116.160
.23	12.144	.83	43.824	1.43	75.504	2.30	121.440
.24	12.672	.84	44.352	1.44	76.032	2.40	126.720
.25	13.200	.85	44.880	1.45	76.560	2.50	132.000
.26	13.728	.86	45.408	1.46	77.088	2.60	137.280
.27	14.256	.87	45.936	1.47	77.616	2.70	142.560
.28	14.784	.88	46.464	1.48	78.144	2.80	147.840
.29	15.312	.89	46.992	1.49	78.672	2.90	153.120
.30	15.840	.90	47.520	1.50	79.200	3.00	158.400
.31	16.368	.91	48.048	1.51	79.728	3.10	163.680
.32	16.896	.92	48.576	1.52	80.256	3.20	168.960
.33	17.424	.93	49.104	1.53	80.784	3.30	174.240
.34	17.952	.94	49.632	1.54	81.312	3.40	179.520
.35	18.480	.95	50.160	1.55	81.840	3.50	184.800
.36	19.008	.96	50.688	1.56	82.368	3.60	190.080
.37	19.536	.97	51.216	1.57	82.896	3.70	195.360
.38	20.064	.98	51.744	1.58	83.424	3.80	200.640
.39	20.592	.99	52.272	1.59	83.952	3.90	205.920
.40	21.120	1.00	52.800	1.60	84.480	4.00	211.200
.41	21.648	1.01	53.328	1.61	85.008	4.10	216.480
.42	22.176	1.02	53.856	1.62	85.536	4.20	221.760
.43	22.704	1.03	54.384	1.63	86.064	4.30	227.040
.44	23.232	1.04	54.912	1.64	86.592	4.40	232.320
.45	23.760	1.05	55.440	1.65	87.120	4.50	237.600
.46	24.288	1.06	55.968	1.66	87.648	4.60	242.880
.47	24.816	1.07	56.496	1.67	88.176	4.70	248.160
.48	25.344	1.08	57.024	1.68	88.704	4.80	253.440
.49	25.872	1.09	57.552	1.69	89.232	4.90	258.720
.50	26.400	1.10	58.080	1.70	89.760	5.00	264.000
.51	26.928	1.11	58.608	1.71	90.288	5.10	269.280
.52	27.456	1.12	59.136	1.72	90.816	5.20	274.560
.53	27.984	1.13	59.664	1.73	91.344	5.30	279.840
.54	28.512	1.14	60.192	1.74	91.872	5.40	285.120
.55	29.040	1.15	60.720	1.75	92.400	5.50	290.400
.56	29.568	1.16	61.248	1.76	92.928	5.60	295.680
.57	30.096	1.17	61.776	1.77	93.456	5.70	300.960
.58	30.624	1.18	62.304	1.78	93.984	5.80	306.240
.59	31.152	1.19	62.832	1.79	94.512	5.90	311.520
.60	31.680	1.20	63.360	1.80	95.040	6.00	316.800

Degree of Curve	Velocity in Miles per Hour											
	10	15	20	25	30	35	40	45	50	55	60	65
0°30′	1/16″	1/16″	1/8″	3/16″	5/16″	3/8″	1/2″	11/16″	13/16″	1″	1 3/16″	1 3/8″
1	1/16	1/8	1/4	7/16	9/16	13/16	1 1/16	1 5/16	1 5/8	2	2 3/8	2 13/16
1 30	1/8	1/4	3/8	5/8	7/8	1 3/16	1 9/16	2	2 1/2	3	3 9/16	4 3/16
2	1/8	5/16	1/2	13/16	1 3/16	1 5/8	2 1/8	2 11/16	3 5/16	4	4 3/4	5 9/16
2 30	3/16	3/8	11/16	1	1 1/2	2	2 5/8	3 5/16	4 1/8	5	5 15/16	6 15/16
3	3/16	7/16	13/16	1 1/4	1 3/4	2 7/16	3 3/16	4	4 15/16	6	7 1/8	8 3/8
3 30	1/4	1/2	15/16	1 7/16	2 1/16	2 13/16	3 11/16	4 11/16	5 3/4	7	8 5/16	
4	1/4	9/16	1 1/16	1 5/8	2 3/8	3 1/4	4 1/4	5 5/16	6 5/8	8	9 1/2	
4 30	5/16	11/16	1 3/16	1 7/8	2 11/16	3 5/8	4 3/4	6	7 7/16	9		
5	5/16	3/4	1 5/16	2 1/16	2 15/16	4 1/16	5 1/4	6 11/16	8 1/4	10		
5 30	3/8	13/16	1 7/16	2 1/4	3 1/4	4 7/16	5 13/16	7 3/8	9 1/16			
6	3/8	7/8	1 9/16	2 1/2	3 9/16	4 7/8	6 5/16	8	9 7/8			
6 30	7/16	15/16	1 11/16	2 11/16	3 7/8	5 1/4	6 7/8	8 11/16				
7	7/16	1 1/16	1 7/8	2 7/8	4 1/8	5 5/8	7 3/8	9 3/8				
7 30	1/2	1 1/8	2	3 1/16	4 7/16	6 1/16	7 15/16					
8	1/2	1 3/16	2 1/8	3 5/16	4 3/4	6 7/16	8 7/16					
8 30	9/16	1 1/4	2 1/4	3 1/2	5 1/16	6 7/8	9					
9	9/16	1 5/16	2 3/8	3 11/16	5 5/16	7 1/4	9 1/2					
9 30	5/8	1 7/16	2 1/2	3 15/16	5 5/8	7 11/16						
10	11/16	1 1/2	2 5/8	4 1/8	5 15/16	8 1/16						
10 30	11/16	1 9/16	2 3/4	4 5/16	6 1/4	8 1/2						
11	3/4	1 5/8	2 7/8	4 9/16	6 1/2	8 7/8						
11 30	3/4	1 11/16	3 1/16	4 3/4	6 13/16	9 5/16						
12	13/16	1 3/4	3 3/16	4 15/16	7 1/8	9 11/16						
12 30	13/16	1 7/8	3 5/16	5 1/8	7 7/16							
13	7/8	1 15/16	3 7/16	5 3/8	7 11/16							
13 30	7/8	2	3 9/16	5 9/16	8							
14	15/16	2 1/16	3 11/16	5 3/4	8 5/16							
14 30	15/16	2 1/8	3 13/16	6	8 5/8							

TABLE XXVI.—INCHES IN DECIMALS OF A FOOT.

In.	0	1	2	3	4	5	6	7	8	9	10	11	In.
0	Feet	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	0
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193	1/32
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219	1/16
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245	3/32
1/8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271	1/8
5/32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297	5/32
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323	3/16
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349	7/32
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375	1/4
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401	9/32
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427	5/16
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453	11/32
3/8	.0313	.1146	.1979	.2813	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479	3/8
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505	13/32
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531	7/16
15/32	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557	15/32
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583	1/2
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609	17/32
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635	9/16
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661	19/32
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688	5/8
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714	21/32
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740	11/16
23/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766	23/32
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792	3/4
25/32	.0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818	25/32
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844	13/16
27/32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870	27/32
7/8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896	7/8
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922	29/32
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948	15/16
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974	31/32
In.	0	1	2	3	4	5	6	7	8	9	10	11	In.

TABLE XXVII.—MIDDLE ORDINATES FOR CURVING RAILS.

Deg. of Curve	Length of Rail 20	22	24	26	27	28	29	30	33	45	60	Deg. of Curve
0°30′	$\frac{1}{16}''$	$\frac{1}{16}''$	$\frac{1}{16}''$	$\frac{1}{16}''$	$\frac{1}{8}''$	$\frac{1}{8}''$	$\frac{1}{8}''$	$\frac{1}{8}''$	$\frac{1}{8}''$	$\frac{1}{4}''$	$\frac{1}{2}''$	0°30′
1	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{15}{16}$	1
1 30	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{13}{16}$	$1\frac{7}{16}$	1 30
2	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{16}$	$1\frac{7}{8}$	2
2 30	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{11}{16}$	$1\frac{5}{16}$	$2\frac{3}{8}$	2 30
3	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{9}{16}$	$2\frac{13}{16}$	3
3 30	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	1	$1\frac{7}{8}$	$3\frac{5}{16}$	3 30
4	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$3\frac{3}{4}$	4
4 30	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{5}{16}$	$2\frac{3}{8}$	$4\frac{1}{4}$	4 30
5	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{7}{16}$	$2\frac{5}{8}$	$4\frac{11}{16}$	5
5 30	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{13}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$1\frac{9}{16}$	$2\frac{15}{16}$	$5\frac{3}{16}$	5 30
6	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{7}{16}$	$1\frac{11}{16}$	$3\frac{3}{16}$	$5\frac{5}{8}$	6
6 30	$\frac{11}{16}$	$\frac{13}{16}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{7}{16}$	$1\frac{9}{16}$	$1\frac{7}{8}$	$3\frac{7}{16}$	$6\frac{1}{8}$	6 30
7	$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{7}{16}$	$1\frac{9}{16}$	$1\frac{5}{8}$	2	$3\frac{11}{16}$	$6\frac{5}{8}$	7
7 30	$\frac{13}{16}$	$\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{7}{16}$	$1\frac{9}{16}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$2\frac{1}{8}$	4	$7\frac{1}{16}$	7 30
8	$\frac{13}{16}$	1	$1\frac{3}{16}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{1}{4}$	$4\frac{1}{4}$	$7\frac{9}{16}$	8
8 30	$\frac{7}{8}$	$1\frac{1}{16}$	$1\frac{5}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{7}{16}$	$4\frac{1}{2}$	8	8 30
9	$\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{9}{16}$	$1\frac{11}{16}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{9}{16}$	$4\frac{3}{4}$	$8\frac{1}{2}$	9
9 30	1	$1\frac{3}{16}$	$1\frac{7}{16}$	$1\frac{11}{16}$	$1\frac{13}{16}$	$1\frac{15}{16}$	$2\frac{1}{16}$	$2\frac{1}{4}$	$2\frac{11}{16}$	$5\frac{1}{16}$	$8\frac{15}{16}$	9 30
10	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{15}{16}$	$2\frac{1}{16}$	$2\frac{3}{16}$	$2\frac{3}{8}$	$2\frac{7}{8}$	$5\frac{5}{16}$	$9\frac{7}{16}$	10
10 30	$1\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{9}{16}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{5}{16}$	$2\frac{1}{2}$	3	$5\frac{9}{16}$	$9\frac{7}{8}$	10 30
11	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{11}{16}$	$1\frac{15}{16}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{7}{16}$	$2\frac{9}{16}$	$3\frac{1}{8}$	$5\frac{13}{16}$	$10\frac{3}{8}$	11
11 30	$1\frac{3}{16}$	$1\frac{7}{16}$	$1\frac{3}{4}$	2	$2\frac{3}{16}$	$2\frac{3}{8}$	$2\frac{9}{16}$	$2\frac{11}{16}$	$3\frac{1}{4}$	$6\frac{1}{8}$	$10\frac{13}{16}$	11 30
12	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{1}{8}$	$2\frac{5}{16}$	$2\frac{7}{16}$	$2\frac{5}{8}$	$2\frac{13}{16}$	$3\frac{7}{16}$	$6\frac{3}{8}$	$11\frac{5}{16}$	12
12 30	$1\frac{5}{16}$	$1\frac{9}{16}$	$1\frac{7}{8}$	$2\frac{3}{16}$	$2\frac{3}{8}$	$2\frac{9}{16}$	$2\frac{3}{4}$	$2\frac{15}{16}$	$3\frac{9}{16}$	$6\frac{5}{8}$	$11\frac{3}{4}$	12 30
13	$1\frac{3}{8}$	$1\frac{5}{8}$	$1\frac{15}{16}$	$2\frac{5}{16}$	$2\frac{1}{2}$	$2\frac{11}{16}$	$2\frac{7}{8}$	$3\frac{1}{16}$	$3\frac{11}{16}$	$6\frac{7}{8}$	$12\frac{1}{4}$	13
13 30	$1\frac{7}{16}$	$1\frac{11}{16}$	$2\frac{1}{16}$	$2\frac{3}{8}$	$2\frac{9}{16}$	$2\frac{3}{4}$	3	$3\frac{3}{16}$	$3\frac{7}{8}$	$7\frac{1}{8}$	$12\frac{3}{4}$	13 30
14	$1\frac{7}{16}$	$1\frac{3}{4}$	$2\frac{1}{8}$	$2\frac{1}{2}$	$2\frac{11}{16}$	$2\frac{7}{8}$	$3\frac{1}{16}$	$3\frac{5}{16}$	4	$7\frac{7}{16}$	$13\frac{3}{16}$	14
14 30	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{3}{16}$	$2\frac{9}{16}$	$2\frac{3}{4}$	3	$3\frac{3}{16}$	$3\frac{7}{16}$	$4\frac{1}{8}$	$7\frac{11}{16}$	$13\frac{11}{16}$	14 30

TABLE XXVIII. — STADIA REDUCTIONS

VERTICAL HEIGHTS

Minutes	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°
0	0.00	1.74	3.49	5.23	6.96	8.68	10.40	12.10	13.78	15.45
2	0.06	1.80	3.55	5.28	7.02	8.74	10.45	12.15	13.84	15.51
4	0.12	1.86	3.60	5.34	7.07	8.80	10.51	12.21	13.89	15.56
6	0.17	1.92	3.66	5.40	7.13	8.85	10.57	12.26	13.95	15.62
8	0.23	1.98	3.72	5.46	7.19	8.91	10.62	12.32	14.01	15.67
10	0.29	2.04	3.78	5.52	7.25	8.97	10.68	12.38	14.06	15.73
12	0.35	2.09	3.84	5.57	7.30	9.03	10.74	12.43	14.12	15.78
14	0.41	2.15	3.90	5.63	7.36	9.08	10.79	12.49	14.17	15.84
16	0.47	2.21	3.95	5.69	7.42	9.14	10.85	12.55	14.23	15.89
18	0.52	2.27	4.01	5.75	7.48	9.20	10.91	12.60	14.28	15.95
20	0.58	2.33	4.07	5.80	7.53	9.25	10.96	12.66	14.34	16.00
22	0.64	2.38	4.13	5.86	7.59	9.31	11.02	12.72	14.40	16.06
24	0.70	2.44	4.18	5.92	7.65	9.37	11.08	12.77	14.45	16.11
26	0.76	2.50	4.24	5.98	7.71	9.43	11.13	12.83	14.51	16.17
28	0.81	2.56	4.30	6.04	7.76	9.48	11.19	12.88	14.56	16.22
30	0.87	2.62	4.36	6.09	7.82	9.54	11.25	12.94	14.62	16.28
32	0.93	2.67	4.42	6.15	7.88	9.60	11.30	13.00	14.67	16.33
34	0.99	2.73	4.48	6.21	7.94	9.65	11.36	13.05	14.73	16.39
36	1.05	2.79	4.53	6.27	7.99	9.71	11.42	13.11	14.79	16.44
38	1.11	2.85	4.59	6.33	8.05	9.77	11.47	13.17	14.84	16.50
40	1.16	2.91	4.65	6.38	8.11	9.83	11.53	13.22	14.90	16.55
42	1.22	2.97	4.71	6.44	8.17	9.88	11.59	13.28	14.95	16.61
44	1.28	3.02	4.76	6.50	8.22	9.94	11.64	13.33	15.01	16.66
46	1.34	3.08	4.82	6.56	8.28	10.00	11.70	13.39	15.06	16.72
48	1.40	3.14	4.88	6.61	8.34	10.05	11.76	13.45	15.12	16.77
50	1.45	3.20	4.94	6.67	8.40	10.11	11.81	13.50	15.17	16.83
52	1.51	3.26	4.99	6.73	8.45	10.17	11.87	13.56	15.23	16.88
54	1.57	3.31	5.05	6.79	8.51	10.22	11.93	13.61	15.28	16.94
56	1.63	3.37	5.11	6.84	8.57	10.28	11.98	13.67	15.34	16.99
58	1.69	3.43	5.17	6.90	8.63	10.34	12.04	13.73	15.40	17.05
60	1.74	3.49	5.23	6.96	8.68	10.40	12.10	13.78	15.45	17.10

HORIZONTAL CORRECTIONS

Dist.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°
100	0.0	0.0	0.1	0.3	0.5	0.8	1.1	1.5	1.9	2.5
200	0.0	0.1	0.2	0.5	1.0	1.5	2.2	3.0	3.9	4.9
300	0.0	0.1	0.4	0.8	1.5	2.3	3.3	4.5	5.8	7.4
400	0.0	0.1	0.5	1.1	2.0	3.0	4.4	6.0	7.8	9.8
500	0.0	0.2	0.6	1.4	2.5	3.8	5.5	7.5	9.7	12.3
600	0.0	0.2	0.7	1.6	2.9	4.6	6.5	8.9	11.6	14.7
700	0.0	0.2	0.8	1.9	3.4	5.3	7.6	10.4	13.6	17.2
800	0.0	0.2	1.0	2.2	3.9	6.1	8.7	11.9	15.5	19.6
900	0.0	0.3	1.1	2.4	4.4	6.8	9.8	13.4	17.5	22.1
1000	0.0	0.3	1.2	2.7	4.9	7.6	10.9	14.9	19.4	24.5

TABLE XXVIII. — STADIA REDUCTIONS

VERTICAL HEIGHTS

Minutes	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°
0	17.10	18.73	20.34	21.92	23.47	25.00	26.50	27.96	29.39	30.78
2	17.16	18.78	20.39	21.97	23.52	25.05	26.55	28.01	29.44	30.83
4	17.21	18.84	20.44	22.02	23.58	25.10	26.59	28.06	29.48	30.87
6	17.26	18.89	20.50	22.08	23.63	25.15	26.64	28.10	29.53	30.92
8	17.32	18.95	20.55	22.13	23.68	25.20	26.69	28.15	29.58	30.97
10	17.37	19.00	20.60	22.18	23.73	25.25	26.74	28.20	29.62	31.01
12	17.43	19.05	20.66	22.23	23.78	25.30	26.79	28.25	29.67	31.06
14	17.48	19.11	20.71	22.28	23.83	25.35	26.84	28.30	29.72	31.10
16	17.54	19.16	20.76	22.34	23.88	25.40	26.89	28.34	29.76	31.15
18	17.59	19.21	20.81	22.39	23.93	25.45	26.94	28.39	29.81	31.19
20	17.65	19.27	20.87	22.44	23.99	25.50	26.99	28.44	29.86	31.24
22	17.70	19.32	20.92	22.49	24.04	25.55	27.04	28.49	29.90	31.28
24	17.76	19.38	20.97	22.54	24.09	25.60	27.09	28.54	29.95	31.33
26	17.81	19.43	21.03	22.60	24.14	25.65	27.13	28.58	30.00	31.38
28	17.86	19.48	21.08	22.65	24.19	25.70	27.18	28.63	30.04	31.42
30	17.92	19.54	21.13	22.70	24.24	25.75	27.23	28.68	30.09	31.47
32	17.97	19.59	21.18	22.75	24.29	25.80	27.28	28.73	30.14	31.51
34	18.03	19.64	21.24	22.80	24.34	25.85	27.33	28.77	30.19	31.56
36	18.08	19.70	21.29	22.85	24.39	25.90	27.38	28.82	30.23	31.60
38	18.14	19.75	21.34	22.91	24.44	25.95	27.43	28.87	30.28	31.65
40	18.19	19.80	21.39	22.96	24.49	26.00	27.48	28.92	30.32	31.69
42	18.24	19.86	21.45	23.01	24.55	26.05	27.52	28.96	30.37	31.74
44	18.30	19.91	21.50	23.06	24.60	26.10	27.57	29.01	30.41	31.78
46	18.35	19.96	21.55	23.11	24.65	26.15	27.62	29.06	30.46	31.83
48	18.41	20.02	21.60	23.16	24.70	26.20	27.67	29.11	30.51	31.87
50	18.46	20.07	21.66	23.22	24.75	26.25	27.72	29.15	30.55	31.92
52	18.51	20.12	21.71	23.27	24.80	26.30	27.77	29.20	30.60	31.96
54	18.57	20.18	21.76	23.32	24.85	26.35	27.81	29.25	30.65	32.01
56	18.62	20.23	21.81	23.37	24.90	26.40	27.86	29.30	30.69	32.05
58	18.68	20.28	21.87	23.42	24.95	26.45	27.91	29.34	30.74	32.09
60	18.73	20.34	21.92	23.47	25.00	26.50	27.96	29.39	30.78	32.14

HORIZONTAL CORRECTIONS

Dist.	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°
100	3.0	3.6	4.3	5.1	5.9	6.7	7.6	8.5	9.5	10.6
200	6.0	7.3	8.6	10.1	11.7	13.4	15.2	17.1	19.1	21.2
300	9.1	10.9	13.0	15.2	17.6	20.1	22.8	25.6	28.6	31.8
400	12.1	14.6	17.3	20.2	23.4	26.8	30.4	34.2	38.2	42.4
500	15.1	18.2	21.6	25.3	29.3	33.5	38.0	42.7	47.7	53.0
600	18.1	21.8	25.9	30.4	35.1	40.2	45.6	51.3	57.3	63.6
700	21.1	25.5	30.2	35.4	41.0	46.9	53.2	59.8	66.8	74.2
800	24.2	29.1	34.6	40.5	46.8	53.6	60.8	68.4	76.4	84.8
900	27.2	32.8	38.9	45.5	52.7	60.3	68.4	76.9	85.9	95.4
1000	30.2	36.4	43.2	50.6	58.5	67.0	76.0	85.5	95.5	106.0

TABLE XXVIII. — STADIA REDUCTIONS

VERTICAL HEIGHTS

Minutes	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°
0	32.14	33.46	34.73	35.97	37.16	38.30	39.40	40.45	41.45	42.40
2	32.18	33.50	34.77	36.01	37.20	38.34	39.44	40.49	41.48	42.43
4	32.23	33.54	34.82	36.05	37.23	38.38	39.47	40.52	41.52	42.46
6	32.27	33.59	34.86	36.09	37.27	38.41	39.51	40.55	41.55	42.49
8	32.32	33.63	34.90	36.13	37.31	38.45	39.54	40.59	41.58	42.53
10	32.36	33.67	34.94	36.17	37.35	38.49	39.58	40.62	41.61	42.56
12	32.41	33.72	34.98	36.21	37.39	38.53	39.61	40.66	41.65	42.59
14	32.45	33.76	35.02	36.25	37.43	38.56	39.65	40.69	41.68	42.62
16	32.49	33.80	35.07	36.29	37.47	38.60	39.69	40.72	41.71	42.65
18	32.54	33.84	35.11	36.33	37.51	38.64	39.72	40.76	41.74	42.68
20	32.58	33.89	35.15	36.37	37.54	38.67	39.76	40.79	41.77	42.71
22	32.63	33.93	35.19	36.41	37.58	38.71	39.79	40.82	41.81	42.74
24	32.67	33.97	35.23	36.45	37.62	38.75	39.83	40.86	41.84	42.77
26	32.72	34.01	35.27	36.49	37.66	38.78	39.86	40.89	41.87	42.80
28	32.76	34.06	35.31	36.53	37.70	38.82	39.90	40.92	41.90	42.83
30	32.80	34.10	35.36	36.57	37.74	38.86	39.93	40.96	41.93	42.86
32	32.85	34.14	35.40	36.61	37.77	38.89	39.97	40.99	41.97	42.89
34	32.89	34.18	35.44	36.65	37.81	38.93	40.00	41.02	42.00	42.92
36	32.93	34.23	35.48	36.69	37.85	38.97	40.04	41.06	42.03	42.95
38	32.98	34.27	35.52	36.73	37.89	39.00	40.07	41.09	42.06	42.98
40	33.02	34.31	35.56	36.77	37.93	39.04	40.11	41.12	42.09	43.01
42	33.07	34.35	35.60	36.80	37.96	39.08	40.14	41.16	42.12	43.04
44	33.11	34.40	35.64	36.84	38.00	39.11	40.18	41.19	42.15	43.07
46	33.15	34.44	35.68	36.88	38.04	39.15	40.21	41.22	42.19	43.10
48	33.20	34.48	35.72	36.92	38.08	39.18	40.24	41.26	42.22	43.13
50	33.24	34.52	35.76	36.96	38.11	39.22	40.28	41.29	42.25	43.16
52	33.28	34.57	35.80	37.00	38.15	39.26	40.31	41.32	42.28	43.18
54	33.33	34.61	35.85	37.04	38.19	39.29	40.35	41.35	42.31	43.21
56	33.37	34.65	35.89	37.08	38.23	39.33	40.38	41.39	42.34	43.24
58	33.41	34.69	35.93	37.12	38.26	39.36	40.42	41.42	42.37	43.27
60	33.46	34.73	35.97	37.16	38.30	39.40	40.45	41.45	42.40	43.30

HORIZONTAL CORRECTIONS

Dist.	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°
100	11.7	12.8	14.0	15.3	16.5	17.9	19.2	20.6	22.0	23.5
200	23.4	25.7	28.1	30.5	33.1	35.7	38.4	41.2	44.1	47.0
300	35.1	38.5	42.1	45.8	49.6	53.6	57.7	61.8	66.1	70.5
400	46.8	51.4	56.1	61.1	66.2	71.4	76.9	82.4	88.2	94.0
500	58.5	64.2	70.2	76.4	82.7	89.3	96.1	103.1	110.2	117.5
600	70.2	77.0	84.2	91.6	99.2	107.2	115.3	123.7	132.2	141.0
700	81.9	89.9	98.2	106.9	115.8	125.0	134.5	144.3	154.3	164.5
800	93.6	102.7	112.2	122.2	132.3	142.9	153.8	164.9	176.3	188.0
900	105.3	115.6	126.3	137.4	148.9	160.7	173.0	185.5	198.4	211.5
1000	117.0	128.4	140.3	152.7	165.4	178.6	192.2	206.1	220.4	235.0

TABLE XXIX.—MEAN REFRACTIONS IN DECLINATION.

Latitude.	Hour Ang.	DECLINATIONS.								
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
2°30′	0 h	−18″	−12″	−07″	−02″	02″	07″	12″	18″	23″
	2	−18	−12	−07	−02	02	07	12	18	23
	3	−17	−11	−06	−01	03	08	13	19	25
	4	−15	−10	−05	00	05	10	15	21	27
	5	−10	−05	00	+05	10	15	20	26	32
5°	0 h	−15″	−10″	−05″	00″	05″	10″	15″	20″	27″
	2	−15	−10	−05	00	05	10	15	20	27
	3	−13	−08	−03	+02	07	12	17	23	29
	4	−10	−05	00	+05	10	15	20	27	32
	5	−05	00	+05	+10	15	20	27	32	40
7°30′	0 h	−13″	−08″	−02″	02″	08″	13″	18″	24″	29″
	2	−12	−07	−01	03	09	14	19	25	31
	3	−10	−05	00	05	10	15	20	26	32
	4	−05	00	+05	10	15	20	26	32	39
	5	+07	+12	+17	23	29	36	43	51	1′01
10°	0 h	−10″	−05″	00″	05″	10″	15″	20″	26″	32″
	2	−07	−03	02	07	12	17	22	28	34
	3	−05	00	03	08	13	19	25	31	38
	4	00	+05	10	15	20	26	32	39	46
	5	+15	+20	26	32	39	46	55	1′06	1′19
12°30′	0 h	−08″	−02″	02″	08″	13″	18″	24″	30″	36″
	2	−06	00	05	10	15	20	26	32	39
	3	+02	+07	12	17	23	29	36	43	51
	4	+04	+09	14	20	25	31	40	48	55
	5	+21	+27	33	40	48	57	1′08	1′23	1′41
15°	0 h	−05″	00″	05″	10″	15″	21″	27″	33″	40″
	2	−03	02	07	12	18	23	29	36	43
	3	+01	05	11	16	22	28	34	41	49
	4	+08	12	19	24	30	37	44	53	1′04
	5	+29	34	41	49	59	1′10	1′24	1′43	2 08
17°30′	0 h	−02″	02″	08″	13″	18″	24″	30″	36″	44″
	2	00	05	10	15	21	27	33	40	48
	3	+02	10	15	21	27	33	40	48	57
	4	+13	18	23	29	35	43	51	1′01	1′13
	5	+34	41	49	58	1′10	1′23	1′41	2 06	2 42
20°	0 h	00″	05″	10″	15″	21″	27″	33″	40″	48″
	2	03	07	13	18	24	30	36	44	52
	3	06	13	18	24	30	36	44	52	1′02
	4	17	22	28	35	42	50	1′00	1′11	1 26
	5	39	47	57	1′07	1′20	1′37	2 00	2 32	3 25
22°30′	0 h	02″	08″	13″	18″	24″	30″	36″	44″	52″
	2	06	11	15	21	27	33	40	48	57
	3	11	15	21	27	33	40	48	57	1′08
	4	20	26	32	39	46	56	1′07	1′19	1 37
	5	45	53	1′03	1′16	1′31	1′52	2 21	3 07	4 28
25°	0 h	05″	10″	15″	21″	27″	33″	40″	48″	57″
	2	08	14	19	25	31	38	46	54	1′05
	3	12	18	24	30	37	44	53	1′04	1 18
	4	23	29	35	45	53	1′03	1′16	1 31	1 52
	5	49	59	1′10	1′24	1′52	2 07	2 44	3 46	5 43
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°

TABLE XXIX.—MEAN REFRACTIONS IN DECLINATION.

Latitude.	Hour Ang.	DECLINATIONS.								
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
27° 30′	0 h	08″	13″	18″	24″	30″	36″	44″	52″	1′ 02″
	2	11	16	22	28	34	41	49	1′ 00	1 10
	3	17	22	28	35	42	50	1′ 00	1 11	1 26
	4	28	35	42	50	1′ 00	1′ 11	1 26	1 43	2 09
	5	54	1′ 05	1′ 18	1′ 34	1 54	2 24	3 11	4 38	8 15
30°	0 h	10″	15″	21″	27″	33″	40″	48″	57″	1′ 08″
	2	14	19	25	31	38	46	54	1′ 05	1 18
	3	20	26	32	39	47	55	1′ 06	1 19	1 36
	4	32	39	46	52	1′ 06	1′ 19	1 35	1 57	2 29
	5	1′ 00	1′ 10	1′ 24	1′ 52	2 07	2 44	3 46	5 43	13 06
32° 30′	0 h	13″	18″	24″	30″	36″	44″	52″	1′ 02″	1′ 14″
	2	17	22	28	35	42	50	1′ 00	1 11	1 26
	3	23	29	35	43	51	1′ 01	1 13	1 28	1 47
	4	35	43	51	1′ 01	1′ 13	1 27	1 46	2 13	2 54
	5	1′ 03	1′ 15	1′ 31	1 53	2 20	3 05	4 25	7 36	
35°	0 h	15″	21″	27″	33″	40″	48″	57″	1′ 08″	1′ 21″
	2	20	25	32	38	46	55	1′ 05	1 18	1 35
	3	26	33	39	47	56	1′ 07	1 21	1 38	2 00
	4	39	47	56	1′ 07	1′ 20	1 36	1 59	2 32	3 25
	5	1′ 07	1′ 20	1′ 38	2 00	2 34	3 29	5 14	10 16	
37° 30′	0 h	18″	24″	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″
	2	22	28	35	42	50	1′ 00	1 12	1 26	1 45
	3	29	36	43	52	1′ 02	1 14	1 29	1 49	2 16
	4	43	51	1′ 01	1′ 13	1 27	1 49	2 14	2 54	4 05
	5	1′ 11	1′ 26	1 54	2 10	2 49	3 55	6 15	14 58	
40°	0 h	21″	27″	33″	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″
	2	25	32	39	46	52	1′ 06	1 19	1 35	1 57
	3	33	40	48	57	1′ 08	1 21	1 38	2 02	2 36
	4	47	55	1′ 06	1′ 19	1 36	1 58	2 30	3 21	4 59
	5	1′ 15	1′ 31	1 51	2 20	3 05	4 25	7 34	25 18	
42° 30′	0 h	24″	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″
	2	28	35	39	50	1′ 00	1 12	1 26	1 45	2 11
	3	36	43	52	1′ 02	1 13	1 29	1 49	2 17	2 59
	4	50	1′ 00	1′ 11	1 26	1 44	2 10	2 49	3 55	6 16
	5	1′ 19	1 36	1 58	2 30	3 22	5 00	9 24		
45°	0 h	27″	33″	40″	48″	57″	1′ 08″	1′ 21″	1′ 39″	2′ 02″
	2	32	39	46	52	1′ 06	1 19	1 35	1 57	2 29
	3	40	47	56	1′ 07	1 21	1 38	2 00	2 34	3 29
	4	54	1′ 04	1′ 16	1 33	1 54	2 24	3 11	4 38	8 15
	5	1′ 23	1 41	2 05	2 41	3 40	5 40	12 02		
47° 30′	0 h	30″	36″	44″	52″	1′ 02″	1′ 14″	1′ 29″	1′ 49″	2′ 18″
	2	35	42	50	1′ 00	1 12	1 26	1 45	2 01	2 51
	3	43	51	1′ 01	1 13	1 28	1 47	2 15	2 56	4 08
	4	56	1′ 09	1 23	1 40	2 05	2 40	3 39	5 37	11 18
	5	1′ 27	1 46	2 12	2 52	4 01	6 30	16 19		
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°

TABLE XXIX.—MEAN REFRACTIONS IN DECLINATION.

Latitude.	Hour Ang.	DECLINATIONS.								
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°
50°	0 h	33″	40″	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″
	2	38	46	55	1′06	1 18	1 35	1 57	2 28	3 19
	3	47	56	1′06	1 19	1 36	2 29	2 31	3 23	5 02
	4	1′02	1′14	1 29	1 48	2 16	2 58	4 18	6 59	19 47
	5	1 30	1 51	2 19	3 04	4 22	7 28	24 10		
52°30′	0 h	36″	44″	52″	1′02″	1′14″	1′29″	1′49″	2′18″	3′05″
	2	43	50	59	1 11	1 26	1 42	2 23	2 49	3 55
	3	50	1′00	1′11	1 26	1 45	2 11	2 51	2 58	6 22
	4	1′05	1 18	1 35	2 10	2 28	3 19	4 53	8 42	
	5	1 34	1 56	2 27	3 16	4 47	8 52			
55°	0 h	40″	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″
	2	46	55	1′05	1 18	1 34	1 56	2 30	3 15	4 47
	3	55	1′06	1 19	1 35	1 58	2 30	3 21	4 58	9 19
	4	1′10	1 23	1 42	2 06	2 43	3 44	5 49	12 41	
	5	1 37	2 01	2 34	3 28	5 15	10 18			
57°30′	0 h	44″	52″	1′02″	1′14″	1′29″	1′49″	2′18″	3′05″	4 37″
	2	50	59	1 11	1 25	1 43	2 09	2 47	3 51	6 04
	3	58	1′10	1 24	1 42	2 07	2 43	3 45	5 50	12 47
	4	1′11	1 25	1 43	2 10	2 50	3 55	6 14	14 49	
	5	1 41	2 06	2 42	3 42	5 46	12 26			
60°	0 h	48″	57″	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″	5′23″
	2	54	1′04	1 17	1 33	1 54	2 24	3 12	4 38	8 15
	3	1′03	1 15	1 30	1 51	2 20	3 04	4 24	7 31	24 44
	4	1 18	1 34	1 56	2 28	3 18	4 50	8 53		
	5	1 45	2 11	2 50	3 57	6 21	15 32			
62°30′	0 h	52″	1′02″	1′14″	1′29″	1′50″	2′18″	3′00″	4′17″	7′13″
	2	58	1 09	1 23	1 41	2 06	2 43	3 44	5 50	12 44
	3	1′07	1 23	1 38	2 01	2 35	3 30	5 16	10 24	
	4	1 23	1 40	2 05	2 40	3 40	5 37	11 50		
	5	1 48	2 17	2 59	4 14	7 03				
65°	0 h	57″	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″	5′23″	10′51″
	2	1′03	1 16	1 31	1 52	2 21	3 07	4 28	7 44	
	3	1 12	1 27	1 46	2 12	2 52	4 02	6 33		
	4	1 27	1 47	2 13	2 54	4 05	6 40			
	5	1 52	2 22	3 08	4 30	7 52				
67°30′	0 h	1′02″	1′14″	1′29″	1′50″	2′18″	3′00″	4′17″	7′13″	
	2	1 08	1 22	1 40	2 03	2 39	3 37	5 32	11 28	
	3	1 17	1 34	1 55	2 26	3 14	4 44	8 34		
	4	1 32	1 53	2 23	3 14	4 35	8 05			
	5	1 56	2 28	3 17	4 40	8 51				
70°	0 h	1′08″	1′21″	1′39″	2′02″	2′36″	3′33″	5′23″	10′51″	
	2	1 14	1 29	1 50	2 18	3 00	4 17	7 13		
	3	1 23	1 43	2 05	2 41	3 41	5 59	12 15		
	4	1 37	2 00	2 34	3 28	5 20	10 12			
	5	2 02	2 33	3 27	5 11	10 05				
		+20°	+15°	+10°	+5°	0°	−5°	−10°	−15°	−20°

					WIDTH					
					5					
0.1	.09	.19	.28	.37	.46	.56	.65	.74	.83	0.1
.2	.19	.37	.56	.74	.93	1.11	1.30	1.48	1.67	.2
.3	.28	.56	.83	1.11	1.39	1.67	1.94	2.22	2.50	.3
.4	.37	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	.4
0.5	.46	.93	1.39	1.85	2.31	2.78	3.24	3.70	4.17	0.5
.6	.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	.6
.7	.65	1.30	1.94	2.59	3.24	3.89	4.54	5.19	5.83	.7
.8	.74	1.48	2.22	2.96	3.70	4.44	5.19	5.93	6.67	.8
.9	.83	1.67	2.50	3.33	4.17	5.00	5.83	6.67	7.50	.9
1.0	.93	1.85	2.78	3.70	4.63	5.56	6.48	7.41	8.33	1.0
.1	1.02	2.04	3.06	4.07	5.09	6.11	7.13	8.15	9.17	.1
.2	1.11	2.22	3.33	4.44	5.56	6.67	7.78	8.89	10.00	.2
.3	1.20	2.41	3.61	4.81	6.02	7.22	8.43	9.63	10.83	.3
.4	1.30	2.59	3.89	5.19	6.48	7.78	9.07	10.37	11.67	.4
1.5	1.39	2.78	4.17	5.56	6.94	8.33	9.72	11.11	12.50	1.5
.6	1.48	2.96	4.44	5.93	7.41	8.89	10.37	11.85	13.33	.6
.7	1.57	3.15	4.72	6.30	7.87	9.44	11.02	12.59	14.17	.7
.8	1.67	3.33	5.00	6.67	8.33	10.00	11.67	13.33	15.00	.8
.9	1.76	3.52	5.28	7.04	8.80	10.56	12.31	14.07	15.83	.9
2.0	1.85	3.70	5.56	7.41	9.26	11.11	12.96	14.81	16.67	2.0
.1	1.94	3.89	5.83	7.78	9.72	11.67	13.61	15.56	17.50	.1
.2	2.04	4.07	6.11	8.15	10.19	12.22	14.26	16.30	18.33	.2
.3	2.13	4.26	6.39	8.52	10.65	12.78	14.91	17.04	19.17	.3
.4	2.22	4.44	6.67	8.89	11.11	13.33	15.56	17.78	20.00	.4
2.5	2.31	4.63	6.94	9.26	11.57	13.89	16.20	18.52	20.83	2.5
.6	2.41	4.81	7.22	9.63	12.04	14.44	16.85	19.26	21.67	.6
.7	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00	22.50	.7
.8	2.59	5.19	7.78	10.37	12.96	15.56	18.15	20.74	23.33	.8
.9	2.69	5.37	8.06	10.74	13.43	16.11	18.80	21.48	24.17	.9
3.0	2.78	5.56	8.33	11.11	13.89	16.67	19.44	22.22	25.00	3.0
.1	2.87	5.74	8.61	11.48	14.35	17.22	20.09	22.96	25.83	.1
.2	2.96	5.93	8.89	11.85	14.81	17.78	20.74	23.70	26.67	.2
.3	3.06	6.11	9.17	12.22	15.28	18.33	21.39	24.44	27.50	.3
.4	3.15	6.30	9.44	12.59	15.74	18.89	22.04	25.19	28.33	.4
3.5	3.24	6.48	9.72	12.96	16.20	19.44	22.69	25.93	29.17	3.5
.6	3.33	6.67	10.00	13.33	16.67	20.00	23.33	26.67	30.00	.6
.7	3.43	6.85	10.28	13.70	17.13	20.56	23.98	27.41	30.83	.7
.8	3.52	7.04	10.56	14.07	17.59	21.11	24.63	28.15	31.67	.8
.9	3.61	7.22	10.83	14.44	18.06	21.67	25.28	28.89	32.50	.9
4.0	3.70	7.41	11.11	14.81	18.52	22.22	25.93	29.63	33.33	4.0
.1	3.80	7.59	11.39	15.19	18.98	22.78	26.57	30.37	34.17	.1
.2	3.89	7.78	11.67	15.56	19.44	23.33	27.22	31.11	35.00	.2
.3	3.98	7.96	11.94	15.93	19.91	23.89	27.87	31.85	35.83	.3
.4	4.07	8.15	12.22	16.30	20.37	24.44	28.52	32.59	36.67	.4
4.5	4.17	8.33	12.50	16.67	20.83	25.00	29.17	33.33	37.50	4.5
.6	4.26	8.52	12.78	17.04	21.30	25.56	29.81	34.07	38.33	.6
.7	4.35	8.70	13.06	17.41	21.76	26.11	30.46	34.81	39.17	.7
.8	4.44	8.89	13.33	17.78	22.22	26.67	31.11	35.56	40.00	.8
.9	4.54	9.07	13.61	18.15	22.69	27.22	31.76	36.30	40.83	.9
5.0	4.63	9.26	13.89	18.52	23.15	27.78	32.41	37.04	41.67	5.0
.1	4.72	9.44	14.17	18.89	23.61	28.33	33.06	37.78	42.50	.1
.2	4.81	9.63	14.44	19.26	24.07	28.89	33.70	38.52	43.33	.2
.3	4.91	9.81	14.72	19.63	24.54	29.44	34.35	39.26	44.17	.3
.4	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	.4
5.5	5.09	10.19	15.28	20.37	25.46	30.56	35.65	40.74	45.83	5.5
.6	5.19	10.37	15.56	20.74	25.93	31.11	36.30	41.48	46.67	.6
.7	5.28	10.56	15.83	21.11	26.39	31.67	36.94	42.22	47.50	.7
.8	5.37	10.74	16.11	21.48	26.85	32.22	37.59	42.96	48.33	.8
.9	5.46	10.93	16.39	21.85	27.31	32.78	38.24	43.70	49.17	.9
	1	2	3	4	5	6	7			

	WIDTH									
Hght	1	2	3	4	5					Hght
6.0	5.56	11.11	16.67	22.22	27.78	33.33	38.89	44.44	50.00	6.0
.1	5.65	11.30	16.94	22.59	28.24	33.89	39.54	45.19	50.83	.1
.2	5.74	11.48	17.22	22.96	28.70	34.44	40.19	45.93	51.67	.2
.3	5.83	11.67	17.50	23.33	29.17	35.00	40.83	46.67	52.50	.3
.4	5.93	11.85	17.78	23.70	29.63	35.56	41.48	47.41	53.33	.4
6.5	6.02	12.04	18.06	24.07	30.09	36.11	42.13	48.15	54.17	6.5
.6	6.11	12.22	18.33	24.44	30.56	36.67	42.78	48.89	55.00	.6
.7	6.20	12.41	18.61	24.81	31.02	37.22	43.43	49.63	55.83	.7
.8	6.30	12.59	18.89	25.19	31.48	37.78	44.07	50.37	56.67	.8
.9	6.39	12.78	19.17	25.56	31.94	38.33	44.72	51.11	57.50	.9
7.0	6.48	12.96	19.44	25.93	32.41	38.89	45.37	51.85	58.33	7.0
.1	6.57	13.15	19.72	26.30	32.87	39.44	46.02	52.59	59.17	.1
.2	6.67	13.33	20.00	26.67	33.33	40.00	46.67	53.33	60.00	.2
.3	6.76	13.52	20.28	27.04	33.80	40.56	47.31	54.07	60.83	.3
.4	6.85	13.70	20.56	27.41	34.26	41.11	47.96	54.81	61.67	.4
7.5	6.94	13.89	20.83	27.78	34.72	41.67	48.61	55.56	62.50	7.5
.6	7.04	14.07	21.11	28.15	35.19	42.22	49.26	56.30	63.33	.6
.7	7.13	14.26	21.39	28.52	35.65	42.78	49.91	57.04	64.17	.7
.8	7.22	14.44	21.67	28.89	36.11	43.33	50.56	57.78	65.00	.8
.9	7.31	14.63	21.94	29.26	36.57	43.89	51.20	58.52	65.83	.9
8.0	7.41	14.81	22.22	29.63	37.04	44.44	51.85	59.26	66.67	8.0
.1	7.50	15.00	22.50	30.00	37.50	45.00	52.50	60.00	67.50	.1
.2	7.59	15.19	22.78	30.37	37.96	45.56	53.15	60.74	68.33	.2
.3	7.69	15.37	23.06	30.74	38.43	46.11	53.80	61.48	69.17	.3
.4	7.78	15.56	23.33	31.11	38.89	46.67	54.44	62.22	70.00	.4
8.5	7.87	15.74	23.61	31.48	39.35	47.22	55.09	62.96	70.83	8.5
.6	7.96	15.93	23.89	31.85	39.81	47.78	55.74	63.70	71.67	.6
.7	8.06	16.11	24.17	32.22	40.28	48.33	56.39	64.44	72.50	.7
.8	8.15	16.30	24.44	32.59	40.74	48.89	57.04	65.19	73.33	.8
.9	8.24	16.48	24.72	32.96	41.20	49.44	57.69	65.93	74.17	.9
9.0	8.33	16.67	25.00	33.33	41.67	50.00	58.33	66.67	75.00	9.0
.1	8.43	16.85	25.28	33.70	42.13	50.56	58.98	67.41	75.83	.1
.2	8.52	17.04	25.56	34.07	42.59	51.11	59.63	68.15	76.67	.2
.3	8.61	17.22	25.83	34.44	43.06	51.67	60.28	68.89	77.50	.3
.4	8.70	17.41	26.11	34.81	43.52	52.22	60.93	69.63	78.33	.4
9.5	8.80	17.59	26.39	35.19	43.98	52.78	61.57	70.37	79.17	9.5
.6	8.89	17.78	26.67	35.56	44.44	53.33	62.22	71.11	80.00	.6
.7	8.98	17.96	26.94	35.93	44.91	53.89	62.87	71.85	80.83	.7
.8	9.07	18.15	27.22	36.30	45.37	54.44	63.52	72.59	81.67	.8
.9	9.17	18.33	27.50	36.67	45.83	55.00	64.17	73.33	82.50	.9
10.0	9.26	18.52	27.78	37.04	46.30	55.56	64.81	74.07	83.33	10.0
.1	9.35	18.70	28.06	37.41	46.76	56.11	65.46	74.81	84.17	.1
.2	9.44	18.89	28.33	37.78	47.22	56.67	66.11	75.56	85.00	.2
.3	9.54	19.07	28.61	38.15	47.69	57.22	66.76	76.30	85.83	.3
.4	9.63	19.26	28.89	38.52	48.15	57.78	67.41	77.04	86.67	.4
10.5	9.72	19.44	29.17	38.89	48.61	58.33	68.06	77.78	87.50	10.5
.6	9.81	19.63	29.44	39.26	49.07	58.89	68.70	78.52	88.33	.6
.7	9.91	19.81	29.72	39.63	49.54	59.44	69.35	79.26	89.17	.7
.8	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	.8
.9	10.09	20.19	30.28	40.37	50.46	60.56	70.65	80.74	90.83	.9
11.0	10.19	20.37	30.56	40.74	50.93	61.11	71.30	81.48	91.67	11.0
.1	10.28	20.56	30.83	41.11	51.39	61.67	71.94	82.22	92.50	.1
.2	10.37	20.74	31.11	41.48	51.85	62.22	72.59	82.96	93.33	.2
.3	10.46	20.93	31.39	41.85	52.31	62.78	73.24	83.70	94.17	.3
.4	10.56	21.11	31.67	42.22	52.78	63.33	73.89	84.44	95.00	.4
11.5	10.65	21.30	31.94	42.59	53.24	63.89	74.54	85.19	95.83	11.5
.6	10.74	21.48	32.22	42.96	53.70	64.44	75.19	85.93	96.67	.6
.7	10.83	21.67	32.50	43.33	54.17	65.00	75.83	86.67	97.50	.7
.8	10.93	21.85	32.78	43.70	54.63	65.56	76.48	87.41	98.33	.8
.9	11.02	22.04	33.06	44.07	55.09	66.11	77.13	88.15	99.17	.9

				WIDTH						
				4	5	6	7	8	9	Hght
12.0	11.11	22.22	33.33	44.44	55.56	66.67	77.78	88.89	100.00	12.0
.1	11.20	22.41	33.61	44.81	56.02	67.22	78.43	89.63	100.83	.1
.2	11.30	22.59	33.89	45.19	56.48	67.78	79.07	90.37	101.67	.2
.3	11.39	22.78	34.17	45.56	56.94	68.33	79.72	91.11	102.50	.3
.4	11.48	22.96	34.44	45.93	57.41	68.89	80.37	91.85	103.33	.4
12.5	11.57	23.15	34.72	46.30	57.87	69.44	81.02	92.59	104.17	12.5
.6	11.67	23.33	35.00	46.67	58.33	70.00	81.67	93.33	105.00	.6
.7	11.76	23.52	35.28	47.04	58.80	70.56	82.31	94.07	105.83	.7
.8	11.85	23.70	35.56	47.41	59.26	71.11	82.96	94.81	106.67	.8
.9	11.94	23.89	35.83	47.78	59.72	71.67	83.61	95.56	107.50	.9
13.0	12.04	24.07	36.11	48.15	60.19	72.22	84.26	96.30	108.33	13.0
.1	12.13	24.26	36.39	48.52	60.65	72.78	84.91	97.04	109.17	.1
.2	12.22	24.44	36.67	48.89	61.11	73.33	85.56	97.78	110.00	.2
.3	12.31	24.63	36.94	49.26	61.57	73.89	86.20	98.52	110.83	.3
.4	12.41	24.81	37.22	49.63	62.04	74.44	86.85	99.26	111.67	.4
13.5	12.50	25.00	37.50	50.00	62.50	75.00	87.50	100.00	112.50	13.5
.6	12.59	25.19	37.78	50.37	62.96	75.56	88.15	100.74	113.33	.6
.7	12.69	25.37	38.06	50.74	63.43	76.11	88.80	101.48	114.17	.7
.8	12.78	25.56	38.33	51.11	63.89	76.67	89.44	102.22	115.00	.8
.9	12.87	25.74	38.61	51.48	64.35	77.22	90.09	102.96	115.83	.9
14.0	12.96	25.93	38.89	51.85	64.81	77.78	90.74	103.70	116.67	14.0
.1	13.06	26.11	39.17	52.22	65.28	78.33	91.39	104.44	117.50	.1
.2	13.15	26.30	39.44	52.59	65.74	78.89	92.04	105.19	118.33	.2
.3	13.24	26.48	39.72	52.96	66.20	79.44	92.69	105.93	119.17	.3
.4	13.33	26.67	40.00	53.33	66.67	80.00	93.33	106.67	120.00	.4
14.5	13.43	26.85	40.28	53.70	67.13	80.56	93.98	107.41	120.83	14.5
.6	13.52	27.04	40.56	54.07	67.59	81.11	94.63	108.15	121.67	.6
.7	13.61	27.22	40.83	54.44	68.06	81.67	95.28	108.89	122.50	.7
.8	13.70	27.41	41.11	54.81	68.52	82.22	95.93	109.63	123.33	.8
.9	13.80	27.59	41.39	55.19	68.98	82.78	96.57	110.37	124.17	.9
15.0	13.89	27.78	41.67	55.56	69.44	83.33	97.22	111.11	125.00	15.0
.1	13.98	27.96	41.94	55.93	69.91	83.89	97.87	111.85	125.83	.1
.2	14.07	28.15	42.22	56.30	70.37	84.44	98.52	112.59	126.67	.2
.3	14.17	28.33	42.50	56.67	70.83	85.00	99.17	113.33	127.50	.3
.4	14.26	28.52	42.78	57.04	71.30	85.56	99.81	114.07	128.33	.4
15.5	14.35	28.70	43.06	57.41	71.76	86.11	100.46	114.81	129.17	15.5
.6	14.44	28.89	43.33	57.78	72.22	86.67	101.11	115.56	130.00	.6
.7	14.54	29.07	43.61	58.15	72.69	87.22	101.76	116.30	130.83	.7
.8	14.63	29.26	43.89	58.52	73.15	87.78	102.41	117.04	131.67	.8
.9	14.72	29.44	44.17	58.89	73.61	88.33	103.06	117.78	132.50	.9
16.0	14.81	29.63	44.44	59.26	74.07	88.89	103.70	118.52	133.33	16.0
.1	14.91	29.81	44.72	59.63	74.54	89.44	104.35	119.26	134.17	.1
.2	15.00	30.00	45.00	60.00	75.00	90.00	105.00	120.00	135.00	.2
.3	15.09	30.19	45.28	60.37	75.46	90.56	105.65	120.74	135.83	.3
.4	15.19	30.37	45.56	60.74	75.93	91.11	106.30	121.48	136.67	.4
16.5	15.28	30.56	45.83	61.11	76.39	91.67	106.94	122.22	137.50	16.5
.6	15.37	30.74	46.11	61.48	76.85	92.22	107.59	122.96	138.33	.6
.7	15.46	30.93	46.39	61.85	77.31	92.78	108.24	123.70	139.17	.7
.8	15.56	31.11	46.67	62.22	77.78	93.33	108.89	124.44	140.00	.8
.9	15.65	31.30	46.94	62.59	78.24	93.89	109.54	125.19	140.83	.9
17.0	15.74	31.48	47.22	62.96	78.70	94.44	110.19	125.93	141.67	17.0
.1	15.83	31.67	47.50	63.33	79.17	95.00	110.83	126.67	142.50	.1
.2	15.93	31.85	47.78	63.70	79.63	95.56	111.48	127.41	143.33	.2
.3	16.02	32.04	48.06	64.07	80.09	96.11	112.13	128.15	144.17	.3
.4	16.11	32.22	48.33	64.44	80.56	96.67	112.78	128.89	145.00	.4
17.5	16.20	32.41	48.61	64.81	81.02	97.22	113.43	129.63	145.83	17.5
.6	16.30	32.59	48.89	65.19	81.48	97.78	114.07	130.37	146.67	.6
.7	16.39	32.78	49.17	65.56	81.94	98.33	114.72	131.11	147.50	.7
.8	16.48	32.96	49.44	65.93	82.41	98.89	115.37	131.85	148.33	.8
.9	16.57	33.15	49.72	66.30	82.87	99.44	116.02	132.59	149.17	.9
					5	6	7	8	9	

Height	WIDTH 1	2	3	4	5	6	7	8	9	Height
18.0	16.67	33.33	50.00	66.67	83.33	100.00	116.67	133.33	150.00	18.0
.1	16.76	33.52	50.28	67.04	83.80	100.56	117.31	134.07	150.83	.1
.2	16.85	33.70	50.56	67.41	84.26	101.11	117.96	134.81	151.67	.2
.3	16.94	33.89	50.83	67.78	84.72	101.67	118.61	135.56	152.50	.3
.4	17.04	34.07	51.11	68.15	85.19	102.22	119.26	136.30	153.33	.4
18.5	17.13	34.26	51.39	68.52	85.65	102.78	119.91	137.04	154.17	18.5
.6	17.22	34.44	51.67	68.89	86.11	103.33	120.56	137.78	155.00	.6
.7	17.31	34.63	51.94	69.26	86.57	103.89	121.20	138.52	155.83	.7
.8	17.41	34.81	52.22	69.63	87.04	104.44	121.85	139.26	156.67	.8
.9	17.50	35.00	52.50	70.00	87.50	105.00	122.50	140.00	157.50	.9
19.0	17.59	35.19	52.78	70.37	87.96	105.56	123.15	140.74	158.33	19.0
.1	17.69	35.37	53.06	70.74	88.43	106.11	123.80	141.48	159.17	.1
.2	17.78	35.56	53.33	71.11	88.89	106.67	124.44	142.22	160.00	.2
.3	17.87	35.74	53.61	71.48	89.35	107.22	125.09	142.96	160.83	.3
.4	17.96	35.93	53.89	71.85	89.81	107.78	125.74	143.70	161.67	.4
19.5	18.06	36.11	54.17	72.22	90.28	108.33	126.39	144.44	162.50	19.5
.6	18.15	36.30	54.44	72.59	90.74	108.89	127.04	145.19	163.33	.6
.7	18.24	36.48	54.72	72.96	91.20	109.44	127.69	145.93	164.17	.7
.8	18.33	36.67	55.00	73.33	91.67	110.00	128.33	146.67	165.00	.8
.9	18.43	36.85	55.28	73.70	92.13	110.56	128.98	147.41	165.83	.9
20.0	18.52	37.04	55.56	74.07	92.59	111.11	129.63	148.15	166.67	20.0
.1	18.61	37.22	55.83	74.44	93.06	111.67	130.28	148.89	167.50	.1
.2	18.70	37.41	56.11	74.81	93.52	112.22	130.93	149.63	168.33	.2
.3	18.80	37.59	56.39	75.19	93.98	112.78	131.57	150.37	169.17	.3
.4	18.89	37.78	56.67	75.56	94.44	113.33	132.22	151.11	170.00	.4
20.5	18.98	37.96	56.94	75.93	94.91	113.89	132.87	151.85	170.83	20.5
.6	19.07	38.15	57.22	76.30	95.37	114.44	133.52	152.59	171.67	.6
.7	19.17	38.33	57.50	76.67	95.83	115.00	134.17	153.33	172.50	.7
.8	19.26	38.52	57.78	77.04	96.30	115.56	134.81	154.07	173.33	.8
.9	19.35	38.70	58.06	77.41	96.76	116.11	135.46	154.81	174.17	.9
21.0	19.44	38.89	58.33	77.78	97.22	116.67	136.11	155.56	175.00	21.0
.1	19.54	39.07	58.61	78.15	97.69	117.22	136.76	156.30	175.83	.1
.2	19.63	39.26	58.89	78.52	98.15	117.78	137.41	157.04	176.67	.2
.3	19.72	39.44	59.17	78.89	98.61	118.33	138.06	157.78	177.50	.3
.4	19.81	39.63	59.44	79.26	99.07	118.89	138.70	158.52	178.33	.4
21.5	19.91	39.81	59.72	79.63	99.54	119.44	139.35	159.26	179.17	21.5
.6	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	.6
.7	20.09	40.19	60.28	80.37	100.46	120.56	140.65	160.74	180.83	.7
.8	20.19	40.37	60.56	80.74	100.93	121.11	141.30	161.48	181.67	.8
.9	20.28	40.56	60.83	81.11	101.39	121.67	141.94	162.22	182.50	.9
22.0	20.37	40.74	61.11	81.48	101.85	122.22	142.59	162.96	183.33	22.0
.1	20.46	40.93	61.39	81.85	102.31	122.78	143.24	163.70	184.17	.1
.2	20.56	41.11	61.67	82.22	102.78	123.33	143.89	164.44	185.00	.2
.3	20.65	41.30	61.94	82.59	103.24	123.89	144.54	165.19	185.83	.3
.4	20.74	41.48	62.22	82.96	103.70	124.44	145.19	165.93	186.67	.4
22.5	20.83	41.67	62.50	83.33	104.17	125.00	145.83	166.67	187.50	22.5
.6	20.93	41.85	62.78	83.70	104.63	125.56	146.48	167.41	188.33	.6
.7	21.02	42.04	63.06	84.07	105.09	126.11	147.13	168.15	189.17	.7
.8	21.11	42.22	63.33	84.44	105.56	126.67	147.78	168.89	190.00	.8
.9	21.20	42.41	63.61	84.81	106.02	127.22	148.43	169.63	190.83	.9
23.0	21.30	42.59	63.89	85.19	106.48	127.78	149.07	170.37	191.67	23.0
.1	21.39	42.78	64.17	85.56	106.94	128.33	149.72	171.11	192.50	.1
.2	21.48	42.96	64.44	85.93	107.41	128.89	150.37	171.85	193.33	.2
.3	21.57	43.15	64.72	86.30	107.87	129.44	151.02	172.59	194.17	.3
.4	21.67	43.33	65.00	86.67	108.33	130.00	151.67	173.33	195.00	.4
23.5	21.76	43.52	65.28	87.04	108.80	130.56	152.31	174.07	195.83	23.5
.6	21.85	43.70	65.56	87.41	109.26	131.11	152.96	174.81	196.67	.6
.7	21.94	43.89	65.83	87.78	109.72	131.67	153.61	175.56	197.50	.7
.8	22.04	44.07	66.11	88.15	110.19	132.22	154.26	176.30	198.33	.8
.9	22.13	44.26	66.39	88.52	110.65	132.78	154.91	177.04	199.17	.9

Hght.					WIDTH 5					Hght.
[illegible] .0	27 78	55 56	83 33	111 11	138 89	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	27 87	55 74	83 61	111 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	250.83	.1
.2	27 96	55 93	83 [illegible]	111 [illegible]	139 81	[illegible]	195 74	[illegible]	251.67	.2
.3	[illegible]	[illegible]	[illegible] 17	[illegible]	[illegible]	[illegible] 33	[illegible]	[illegible]	[illegible]	.3
.4	[illegible].15	[illegible]	[illegible] 44	[illegible] 59	[illegible] 74	[illegible]	[illegible]	[illegible]	253.33	.4
.5	[illegible]	[illegible] 48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.5
.6	[illegible] 33	[illegible] 67	[illegible]	[illegible] 33	[illegible]	[illegible]	[illegible] 33	[illegible] 67	255.00	.6
.7	[illegible]	[illegible]	[illegible]	[illegible] 70	[illegible] 13	[illegible]	[illegible]	227 41	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	228.15	[illegible]	.8
.9	[illegible]	57 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	257.50	.9
[illegible] .0	[illegible]	57 41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	229.63	[illegible]	[illegible] .0
.1	[illegible]	57 59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 37	230.37	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	260.83	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 37	[illegible]	[illegible]	[illegible]	261.67	.4
.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	233.33	262.50	.5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	235.56	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	236.30	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	270.83	.5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	275.00	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	157 41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	252.59	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	287.50	.5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	258.52	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	226.85	[illegible]	291.67	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	227 50	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	228.80	261.48	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	163 [illegible]	[illegible]	229 44	[illegible]	[illegible]	.4
.5	[illegible]	65 74	[illegible]	[illegible]	164 35	[illegible]	230.09	[illegible]	[illegible]	.5
.6	[illegible]	[illegible]	[illegible]	[illegible]	164 81	[illegible] 78	230.74	[illegible]	[illegible]	.6
.7	33.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	264.44	[illegible]	.7
.8	33.15	66 30	[illegible] 44	[illegible]	[illegible] 74	[illegible]	[illegible]	265.19	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9

Hght	WIDTH 1	2	3	4	5	6	7	8	9	Hght
36.0	33.33	66.67	100.00	133.33	166.67	200.00	233.33	266.67	300.00	36.0
.1	33.43	66.85	100.28	133.70	167.13	200.56	233.98	267.41	300.83	.1
.2	33.52	67.04	100.56	134.07	167.59	201.11	234.63	268.15	301.67	.2
.3	33.61	67.22	100.83	134.44	168.06	201.67	235.28	268.89	302.50	.3
.4	33.70	67.41	101.11	134.81	168.52	202.22	235.93	269.63	303.33	.4
36.5	33.80	67.59	101.39	135.19	168.98	202.78	236.57	270.37	304.17	36.5
.6	33.89	67.78	101.67	135.56	169.44	203.33	237.22	271.11	305.00	.6
.7	33.98	67.96	101.94	135.93	169.91	203.89	237.87	271.85	305.83	.7
.8	34.07	68.15	102.22	136.30	170.37	204.44	238.52	272.59	306.67	.8
.9	34.17	68.33	102.50	136.67	170.83	205.00	239.17	273.33	307.50	.9
37.0	34.26	68.52	102.78	137.04	171.30	205.56	239.81	274.07	308.33	37.0
.1	34.35	68.70	103.06	137.41	171.76	206.11	240.46	274.81	309.17	.1
.2	34.44	68.89	103.33	137.78	172.22	206.67	241.11	275.56	310.00	.2
.3	34.54	69.07	103.61	138.15	172.69	207.22	241.76	276.30	310.83	.3
.4	34.63	69.26	103.89	138.52	173.15	207.78	242.41	277.04	311.67	.4
37.5	34.72	69.44	104.17	138.89	173.61	208.33	243.06	277.78	312.50	37.5
.6	34.81	69.63	104.44	139.26	174.07	208.89	243.70	278.52	313.33	.6
.7	34.91	69.81	104.72	139.63	174.54	209.44	244.35	279.26	314.17	.7
.8	35.00	70.00	105.00	140.00	175.00	210.00	245.00	280.00	315.00	.8
.9	35.09	70.19	105.28	140.37	175.46	210.56	245.65	280.74	315.83	.9
38.0	35.19	70.37	105.56	140.74	175.93	211.11	246.30	281.48	316.67	38.0
.1	35.28	70.56	105.83	141.11	176.39	211.67	246.94	282.22	317.50	.1
.2	35.37	70.74	106.11	141.48	176.85	212.22	247.59	282.96	318.33	.2
.3	35.46	70.93	106.39	141.85	177.31	212.78	248.24	283.70	319.17	.3
.4	35.56	71.11	106.67	142.22	177.78	213.33	248.89	284.44	320.00	.4
38.5	35.65	71.30	106.94	142.59	178.24	213.89	249.54	285.19	320.83	38.5
.6	35.74	71.48	107.22	142.96	178.70	214.44	250.19	285.93	321.67	.6
.7	35.83	71.67	107.50	143.33	179.17	215.00	250.83	286.67	322.50	.7
.8	35.93	71.85	107.78	143.70	179.63	215.56	251.48	287.41	323.33	.8
.9	36.02	72.04	108.06	144.07	180.09	216.11	252.13	288.15	324.17	.9
39.0	36.11	72.22	108.33	144.44	180.56	216.67	252.78	288.89	325.00	39.0
.1	36.20	72.41	108.61	144.81	181.02	217.22	253.43	289.63	325.83	.1
.2	36.30	72.59	108.89	145.19	181.48	217.78	254.07	290.37	326.67	.2
.3	36.39	72.78	109.17	145.56	181.94	218.33	254.72	291.11	327.50	.3
.4	36.48	72.96	109.44	145.93	182.41	218.89	255.37	291.85	328.33	.4
39.5	36.57	73.15	109.72	146.30	182.87	219.44	256.02	292.59	329.17	39.5
.6	36.67	73.33	110.00	146.67	183.33	220.00	256.67	293.33	330.00	.6
.7	36.76	73.52	110.28	147.04	183.80	220.56	257.31	294.07	330.83	.7
.8	36.85	73.70	110.56	147.41	184.26	221.11	257.96	294.81	331.67	.8
.9	36.94	73.89	110.83	147.78	184.72	221.67	258.61	295.56	332.50	.9
40.0	37.04	74.07	111.11	148.15	185.19	222.22	259.26	296.30	333.33	40.0
.1	37.13	74.26	111.39	148.52	185.65	222.78	259.91	297.04	334.17	.1
.2	37.22	74.44	111.67	148.89	186.11	223.33	260.56	297.78	335.00	.2
.3	37.31	74.63	111.94	149.26	186.57	223.89	261.20	298.52	335.83	.3
.4	37.41	74.81	112.22	149.63	187.04	224.44	261.85	299.26	336.67	.4
40.5	37.50	75.00	112.50	150.00	187.50	225.00	262.50	300.00	337.50	40.5
.6	37.59	75.19	112.78	150.37	187.96	225.56	263.15	300.74	338.33	.6
.7	37.69	75.37	113.06	150.74	188.43	226.11	263.80	301.48	339.17	.7
.8	37.78	75.56	113.33	151.11	188.89	226.67	264.44	302.22	340.00	.8
.9	37.87	75.74	113.61	151.48	189.35	227.22	265.09	302.96	340.83	.9
41.0	37.96	75.93	113.89	151.85	189.81	227.78	265.74	303.70	341.67	41.0
.1	38.06	76.11	114.17	152.22	190.28	228.33	266.39	304.44	342.50	.1
.2	38.15	76.30	114.44	152.59	190.74	228.89	267.04	305.19	343.33	.2
.3	38.24	76.48	114.72	152.96	191.20	229.44	267.69	305.93	344.17	.3
.4	38.33	76.67	115.00	153.33	191.67	230.00	268.33	306.67	345.00	.4
41.5	38.43	76.85	115.28	153.70	192.13	230.56	268.98	307.41	345.83	41.5
.6	38.52	77.04	115.56	154.07	192.59	231.11	269.63	308.15	346.67	.6
.7	38.61	77.22	115.83	154.44	193.06	231.67	270.28	308.89	347.50	.7
.8	38.70	77.41	116.11	154.81	193.52	232.22	270.93	309.63	348.33	.8
.9	38.80	77.59	116.39	155.19	193.98	232.78	271.57	310.37	349.17	.9
	1	2	3	4	5	6	7	8	9	

Hght.	Width 1	2	3	4	5	6	7	8	9	Hght.
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	234.44	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
[illegible] .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	276.76	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	277.41	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	278.06	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	278.70	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	80.19	[illegible]	[illegible]	[illegible]	[illegible]	280.65	320.74	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
[illegible] .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	282.59	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	283.24	[illegible]	364.17	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	284.54	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	369.17	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
[illegible] .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	250.36	[illegible]	[illegible]	375.83	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
[illegible] .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	84.81	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	381.67	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	85.19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	213.43	[illegible]	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	213.89	[illegible]	[illegible]	[illegible]	385.00	.2
.3	[illegible]	85.74	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
[illegible] .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	86.30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	86.85	[illegible]	[illegible]	[illegible]	280.56	[illegible]	[illegible]	[illegible]	.9
[illegible] .0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .0
.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	261.67	[illegible]	[illegible]	[illegible]	.1
.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.2
.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.3
.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.4
47 .5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] .5
.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6
.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.7
.8	[illegible]	88.52	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.8
.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	310.46	[illegible]	[illegible]	.9

TABLE XXXI.—PRISMOIDAL CORRECTION. CU. YDS. PER 100 FT.

c_0-c_1	1	2	3	4	5	6	7	8	9	c_0-c_1
D_0-D_1										
0.1	.03	.06								
.2	.06	.12								

c_0-c_1 / D_0-D_1	1	2	3	4	5	6	7	8	9	c_0-c_1 / D_0-D_1
6.0	1.85	3.70	5.56	7.41	9.26	11.11	12.96	14.81	16.67	6.0
.1	1.88	3.77	5.65	7.53	9.41	11.30	13.18	15.06	16.94	.1
.2	1.91	3.83	5.74	7.65	9.57	11.48	13.40	15.31	17.22	.2
.3	1.94	3.89	5.83	7.78	9.72	11.67	13.61	15.56	17.50	.3
.4	1.98	3.95	5.93	7.90	9.88	11.85	13.83	15.80	17.78	.4
6.5	2.01	4.01	6.02	8.02	10.03	12.04	14.04	16.05	18.06	6.5
.6	2.04	4.07	6.11	8.15	10.19	12.22	14.26	16.30	18.33	.6
.7	2.07	4.14	6.20	8.27	10.34	12.41	14.48	16.54	18.61	.7
.8	2.10	4.20	6.30	8.40	10.49	12.59	14.69	16.79	18.89	.8
.9	2.13	4.26	6.39	8.52	10.65	12.78	14.91	17.04	19.17	.9
7.0	2.16	4.32	6.48	8.64	10.80	12.96	15.12	17.28	19.44	7.0
.1	2.19	4.38	6.57	8.77	10.96	13.15	15.34	17.53	19.72	.1
.2	2.22	4.44	6.67	8.89	11.11	13.33	15.56	17.78	20.00	.2
.3	2.25	4.51	6.76	9.01	11.27	13.52	15.77	18.02	20.28	.3
.4	2.28	4.57	6.85	9.14	11.42	13.70	15.99	18.27	20.56	.4
7.5	2.31	4.63	6.94	9.26	11.57	13.89	16.20	18.52	20.83	7.5
.6	2.35	4.69	7.04	9.38	11.73	14.07	16.42	18.77	21.11	.6
.7	2.38	4.75	7.13	9.51	11.88	14.26	16.64	19.01	21.39	.7
.8	2.41	4.81	7.22	9.63	12.04	14.44	16.85	19.26	21.67	.8
.9	2.44	4.88	7.31	9.75	12.19	14.63	17.07	19.51	21.94	.9
8.0	2.47	4.94	7.41	9.88	12.35	14.81	17.28	19.75	22.22	8.0
.1	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00	22.50	.1
.2	2.53	5.06	7.59	10.12	12.65	15.19	17.72	20.25	22.78	.2
.3	2.56	5.12	7.69	10.25	12.81	15.37	17.93	20.49	23.06	.3
.4	2.59	5.19	7.78	10.37	12.96	15.56	18.15	20.74	23.33	.4
8.5	2.62	5.25	7.87	10.49	13.12	15.74	18.36	20.99	23.61	8.5
.6	2.65	5.31	7.96	10.62	13.27	15.93	18.58	21.23	23.89	.6
.7	2.69	5.37	8.06	10.74	13.43	16.11	18.80	21.48	24.17	.7
.8	2.72	5.43	8.15	10.86	13.58	16.30	19.01	21.73	24.44	.8
.9	2.75	5.49	8.24	10.99	13.73	16.48	19.23	21.98	24.72	.9
9.0	2.78	5.56	8.33	11.11	13.89	16.67	19.44	22.22	25.00	9.0
.1	2.81	5.62	8.43	11.23	14.04	16.85	19.66	22.47	25.28	.1
.2	2.84	5.68	8.52	11.36	14.20	17.04	19.88	22.72	25.56	.2
.3	2.87	5.74	8.61	11.48	14.35	17.22	20.09	22.96	25.83	.3
.4	2.90	5.80	8.70	11.60	14.51	17.41	20.31	23.21	26.11	.4
9.5	2.93	5.86	8.80	11.73	14.66	17.59	20.52	23.46	26.39	9.5
.6	2.96	5.93	8.89	11.85	14.81	17.78	20.74	23.70	26.67	.6
.7	2.99	5.99	8.98	11.98	14.97	17.96	20.96	23.95	26.94	.7
.8	3.02	6.05	9.07	12.10	15.12	18.15	21.17	24.20	27.22	.8
.9	3.06	6.11	9.17	12.22	15.28	18.33	21.39	24.44	27.50	.9
10.0	3.09	6.17	9.26	12.35	15.43	18.52	21.60	24.69	27.78	10.0
.1	3.12	6.23	9.35	12.47	15.59	18.70	21.82	24.94	28.06	.1
.2	3.15	6.30	9.44	12.59	15.74	18.89	22.04	25.19	28.33	.2
.3	3.18	6.36	9.54	12.72	15.90	19.07	22.25	25.43	28.61	.3
.4	3.21	6.42	9.63	12.84	16.05	19.26	22.47	25.68	28.89	.4
10.5	3.24	6.48	9.72	12.96	16.20	19.44	22.69	25.93	29.17	10.5
.6	3.27	6.54	9.81	13.09	16.36	19.63	22.90	26.17	29.44	.6
.7	3.30	6.60	9.91	13.21	16.51	19.81	23.12	26.42	29.72	.7
.8	3.33	6.67	10.00	13.33	16.67	20.00	23.33	26.67	30.00	.8
.9	3.36	6.73	10.09	13.46	16.82	20.19	23.55	26.91	30.28	.9
11.0	3.40	6.79	10.19	13.58	16.98	20.37	23.77	27.16	30.56	11.0
.1	3.43	6.85	10.28	13.70	17.13	20.56	23.98	27.41	30.83	.1
.2	3.46	6.91	10.37	13.83	17.28	20.74	24.20	27.65	31.11	.2
.3	3.49	6.98	10.46	13.95	17.44	20.93	24.41	27.90	31.39	.3
.4	3.52	7.04	10.56	14.07	17.59	21.11	24.63	28.15	31.67	.4
11.5	3.55	7.10	10.65	14.20	17.75	21.30	24.85	28.40	31.94	11.5
.6	3.58	7.16	10.74	14.32	17.90	21.48	25.06	28.64	32.22	.6
.7	3.61	7.22	10.83	14.44	18.06	21.67	25.28	28.89	32.50	.7
.8	3.64	7.28	10.93	14.57	18.21	21.85	25.49	29.14	32.78	.8
.9	3.67	7.35	11.02	14.69	18.36	22.04	25.71	29.38	33.06	.9
	1	2	3							

c_0-c_1 / D_0-D_1	1	2	3	4	5	6	7	8	9	c_0-c_1 / D_0-D_1
12.0	3.70	7.41	11.11	14.81	18.52	22.22	25.93	29.63	33.33	12.0
.1	3.73	7.47	11.20	14.94	18.67	22.41	26.14	29.88	33.61	.1
.2	3.77	7.53	11.30	15.06	18.83	22.59	26.36	30.12	33.89	.2
.3	3.80	7.59	11.39	15.19	18.98	22.78	26.57	30.37	34.17	.3
.4	3.83	7.65	11.48	15.31	19.14	22.96	26.79	30.62	34.44	.4
12.5	3.86	7.72	11.57	15.43	19.29	23.15	27.01	30.86	34.72	12.5
.6	3.89	7.78	11.67	15.56	19.44	23.33	27.22	31.11	35.00	.6
.7	3.92	7.84	11.76	15.68	19.60	23.52	27.44	31.36	35.28	.7
.8	3.95	7.90	11.85	15.80	19.75	23.70	27.65	31.60	35.56	.8
.9	3.98	7.96	11.94	15.93	19.91	23.89	27.87	31.85	35.83	.9
13.0	4.01	8.02	12.04	16.05	20.06	24.07	28.09	32.10	36.11	13.0
.1	4.04	8.09	12.13	16.17	20.22	24.26	28.30	32.35	36.39	.1
.2	4.07	8.15	12.22	16.30	20.37	24.44	28.52	32.59	36.67	.2
.3	4.11	8.21	12.31	16.42	20.52	24.63	28.73	32.84	36.94	.3
.4	4.14	8.27	12.41	16.54	20.68	24.81	28.95	33.09	37.22	.4
13.5	4.17	8.33	12.50	16.67	20.83	25.00	29.17	33.33	37.50	13.5
.6	4.20	8.40	12.59	16.79	20.99	25.19	29.38	33.58	37.78	.6
.7	4.23	8.46	12.69	16.91	21.14	25.37	29.60	33.83	38.06	.7
.8	4.26	8.52	12.78	17.04	21.30	25.56	29.81	34.07	38.33	.8
.9	4.29	8.58	12.87	17.16	21.45	25.74	30.03	34.32	38.61	.9
14.0	4.32	8.64	12.96	17.28	21.60	25.93	30.25	34.57	38.89	14.0
.1	4.35	8.70	13.06	17.41	21.76	26.11	30.46	34.81	39.17	.1
.2	4.38	8.77	13.15	17.53	21.91	26.30	30.68	35.06	39.44	.2
.3	4.41	8.83	13.24	17.65	22.07	26.48	30.90	35.31	39.72	.3
.4	4.44	8.89	13.33	17.78	22.22	26.67	31.11	35.56	40.00	.4
14.5	4.48	8.95	13.43	17.90	22.38	26.85	31.33	35.80	40.28	14.5
.6	4.51	9.01	13.52	18.02	22.53	27.04	31.54	36.05	40.56	.6
.7	4.54	9.07	13.61	18.15	22.69	27.22	31.76	36.30	40.83	.7
.8	4.57	9.14	13.70	18.27	22.84	27.41	31.98	36.54	41.11	.8
.9	4.60	9.20	13.80	18.40	22.99	27.59	32.19	36.79	41.39	.9
15.0	4.63	9.26	13.89	18.52	23.15	27.78	32.41	37.04	41.67	15.0
.1	4.66	9.32	13.98	18.64	23.30	27.96	32.62	37.28	41.94	.1
.2	4.69	9.38	14.07	18.77	23.46	28.15	32.84	37.53	42.22	.2
.3	4.72	9.44	14.17	18.89	23.61	28.33	33.06	37.78	42.50	.3
.4	4.75	9.51	14.26	19.01	23.77	28.52	33.27	38.02	42.78	.4
15.5	4.78	9.57	14.35	19.14	23.92	28.70	33.49	38.27	43.06	15.5
.6	4.81	9.63	14.44	19.26	24.07	28.89	33.70	38.52	43.33	.6
.7	4.85	9.69	14.54	19.38	24.23	29.07	33.92	38.77	43.61	.7
.8	4.88	9.75	14.63	19.51	24.38	29.26	34.14	39.01	43.89	.8
.9	4.91	9.81	14.72	19.63	24.54	29.44	34.35	39.26	44.17	.9
16.0	4.94	9.88	14.81	19.75	24.69	29.63	34.57	39.51	44.44	16.0
.1	4.97	9.94	14.91	19.88	24.85	29.81	34.78	39.75	44.72	.1
.2	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	.2
.3	5.03	10.06	15.09	20.12	25.15	30.19	35.22	40.25	45.28	.3
.4	5.06	10.12	15.19	20.25	25.31	30.37	35.43	40.49	45.56	.4
16.5	5.09	10.19	15.28	20.37	25.46	30.56	35.65	40.74	45.83	16.5
.6	5.12	10.25	15.37	20.49	25.62	30.74	35.86	40.99	46.11	.6
.7	5.15	10.31	15.46	20.62	25.77	30.93	36.08	41.23	46.39	.7
.8	5.19	10.37	15.56	20.74	25.93	31.11	36.30	41.48	46.67	.8
.9	5.22	10.43	15.65	20.86	26.08	31.30	36.51	41.73	46.94	.9
17.0	5.25	10.49	15.74	20.99	26.23	31.48	36.73	41.98	47.22	17.0
.1	5.28	10.56	15.83	21.11	26.39	31.67	36.94	42.22	47.50	.1
.2	5.31	10.62	15.93	21.23	26.54	31.85	37.16	42.47	47.78	.2
.3	5.34	10.68	16.02	21.36	26.70	32.04	37.38	42.72	48.06	.3
.4	5.37	10.74	16.11	21.48	26.85	32.22	37.59	42.96	48.33	.4
17.5	5.40	10.80	16.20	21.60	27.01	32.41	37.81	43.21	48.61	17.5
.6	5.43	10.86	16.30	21.73	27.16	32.59	38.02	43.46	48.89	.6
.7	5.46	10.93	16.39	21.85	27.31	32.78	38.24	43.70	49.17	.7
.8	5.49	10.99	16.48	21.98	27.47	32.96	38.46	43.95	49.44	.8
.9	5.52	11.05	16.57	22.10	27.62	33.15	38.67	44.20	49.72	.9
	1	2	3	4	5	6	7	8	9	

TABLE XXXI.—PRISMOIDAL CORRECTION. CU. YDS. PER 100 FT.

$c_0 - c_1$ / $D_0 - D_1$	1	2	3	4	5	6	7	8	9	$c_0 - c_1$ / $D_0 - D_1$
18.0	5.56	11.11	16.67	22.22	27.78	33.33	38.89	44.44	50.00	18.0
.1	5.59	11.17	16.76	22.35	27.93	33.52	39.10	44.69	50.28	.1
.2	5.62	11.23	16.85	22.47	28.09	33.70	39.32	44.94	50.56	.2
.3	5.65	11.30	16.94	22.59	28.24	33.89	39.54	45.19	50.83	.3
.4	5.68	11.36	17.04	22.72	28.40	34.07	39.75	45.43	51.11	.4
18.5	5.71	11.42	17.13	22.84	28.55	34.26	39.97	45.68	51.39	18.5
.6	5.74	11.48	17.22	22.96	28.70	34.44	40.19	45.93	51.67	.6
.7	5.77	11.54	17.31	23.09	28.86	34.63	40.40	46.17	51.94	.7
.8	5.80	11.60	17.41	23.21	29.01	34.81	40.62	46.42	52.22	.8
.9	5.83	11.67	17.50	23.33	29.17	35.00	40.83	46.67	52.50	.9
19.0	5.86	11.73	17.59	23.46	29.32	35.19	41.05	46.91	52.78	19.0
.1	5.90	11.79	17.69	23.58	29.48	35.37	41.27	47.16	53.06	.1
.2	5.93	11.85	17.78	23.70	29.63	35.56	41.48	47.41	53.33	.2
.3	5.96	11.91	17.87	23.83	29.78	35.74	41.70	47.65	53.61	.3
.4	5.99	11.98	17.96	23.95	29.94	35.93	41.91	47.90	53.89	.4
19.5	6.02	12.04	18.06	24.07	30.09	36.11	42.13	48.15	54.17	19.5
.6	6.05	12.10	18.15	24.20	30.25	36.30	42.35	48.40	54.44	.6
.7	6.08	12.16	18.24	24.32	30.40	36.48	42.56	48.64	54.72	.7
.8	6.11	12.22	18.33	24.44	30.56	36.67	42.78	48.89	55.00	.8
.9	6.14	12.28	18.43	24.57	30.71	36.85	42.99	49.14	55.28	.9
20.0	6.17	12.35	18.52	24.69	30.86	37.04	43.21	49.38	55.56	20.0
.1	6.20	12.41	18.61	24.81	31.02	37.22	43.43	49.63	55.83	.1
.2	6.23	12.47	18.70	24.94	31.17	37.41	43.64	49.88	56.11	.2
.3	6.27	12.53	18.80	25.06	31.33	37.59	43.86	50.12	56.39	.3
.4	6.30	12.59	18.89	25.19	31.48	37.78	44.07	50.37	56.67	.4
20.5	6.33	12.65	18.98	25.31	31.64	37.96	44.29	50.62	56.94	20.5
.6	6.36	12.72	19.07	25.43	31.79	38.15	44.51	50.86	57.22	.6
.7	6.39	12.78	19.17	25.56	31.94	38.33	44.72	51.11	57.50	.7
.8	6.42	12.84	19.26	25.68	32.10	38.52	44.94	51.36	57.78	.8
.9	6.45	12.90	19.35	25.80	32.25	38.70	45.15	51.60	58.06	.9
21.0	6.48	12.96	19.44	25.93	32.41	38.89	45.37	51.85	58.33	21.0
.1	6.51	13.02	19.54	26.05	32.56	39.07	45.59	52.10	58.61	.1
.2	6.54	13.09	19.63	26.17	32.72	39.26	45.80	52.35	58.89	.2
.3	6.57	13.15	19.72	26.30	32.87	39.44	46.02	52.59	59.17	.3
.4	6.60	13.21	19.81	26.42	33.02	39.63	46.23	52.84	59.44	.4
21.5	6.64	13.27	19.91	26.54	33.18	39.81	46.45	53.09	59.72	21.5
.6	6.67	13.33	20.00	26.67	33.33	40.00	46.67	53.33	60.00	.6
.7	6.70	13.40	20.09	26.79	33.49	40.19	46.88	53.58	60.28	.7
.8	6.73	13.46	20.19	26.91	33.64	40.37	47.10	53.83	60.56	.8
.9	6.76	13.52	20.28	27.04	33.80	40.56	47.31	54.07	60.83	.9
22.0	6.79	13.58	20.37	27.16	33.95	40.74	47.53	54.32	61.11	22.0
.1	6.82	13.64	20.46	27.28	34.10	40.93	47.75	54.57	61.39	.1
.2	6.85	13.70	20.56	27.41	34.26	41.11	47.96	54.81	61.67	.2
.3	6.88	13.77	20.65	27.53	34.41	41.30	48.18	55.06	61.94	.3
.4	6.91	13.83	20.74	27.65	34.57	41.48	48.40	55.31	62.22	.4
22.5	6.94	13.89	20.83	27.78	34.72	41.67	48.61	55.56	62.50	22.5
.6	6.98	13.95	20.93	27.90	34.88	41.85	48.83	55.80	62.78	.6
.7	7.01	14.01	21.02	28.02	35.03	42.04	49.04	56.05	63.06	.7
.8	7.04	14.07	21.11	28.15	35.19	42.22	49.26	56.30	63.33	.8
.9	7.07	14.14	21.20	28.27	35.34	42.41	49.48	56.54	63.61	.9
23.0	7.10	14.20	21.30	28.40	35.49	42.59	49.69	56.79	63.89	23.0
.1	7.13	14.26	21.39	28.52	35.65	42.78	49.91	57.04	64.17	.1
.2	7.16	14.32	21.48	28.64	35.80	42.96	50.12	57.28	64.44	.2
.3	7.19	14.38	21.57	28.77	35.96	43.15	50.34	57.53	64.72	.3
.4	7.22	14.44	21.67	28.89	36.11	43.33	50.56	57.78	65.00	.4
23.5	7.25	14.51	21.76	29.01	36.27	43.52	50.77	58.02	65.28	23.5
.6	7.28	14.57	21.85	29.14	36.42	43.70	50.99	58.27	65.56	.6
.7	7.31	14.63	21.94	29.26	36.57	43.89	51.20	58.52	65.83	.7
.8	7.35	14.69	22.04	29.38	36.73	44.07	51.42	58.77	66.11	.8
.9	7.38	14.75	22.13	29.51	36.88	44.26	51.64	59.01	66.39	.9

TABLE XXXII.—BASE 14; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	14																				
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	6.5	2.6	6.6	5.3	6.8	8.0	6.9	10.8	7.0	13.7	7.2	16.6	7.3	19.5	7.5	22.5	7.6	25.6	7.7	0
1	28.7	7.9	31.9	8.0	35.1	8.1	38.4	8.3	41.7	8.4	45.1	8.6	48.6	8.7	52.1	8.8	55.7	9.0	59.3	9.1	1
2	63.0	9.3	66.7	9.4	70.5	9.5	74.3	9.7	78.2	9.8	82.2	10.0	86.2	10.1	90.3	10.2	94.4	10.4	98.5	10.5	2
3	102.8	10.6	107.1	10.8	111.4	10.9	115.8	11.1	120.3	11.2	124.8	11.3	129.3	11.5	134.0	11.6	138.6	11.8	143.4	11.9	3
4	148.1	12.0	153.0	12.2	157.9	12.3	162.8	12.5	167.9	12.6	172.9	12.7	178.0	12.9	183.2	13.0	188.4	13.1	193.7	13.3	4
5	199.1	13.4	204.5	13.6	209.9	13.7	215.4	13.8	221.0	14.0	226.6	14.1	232.3	14.3	238.0	14.4	243.8	14.5	249.7	14.7	5
6	255.6	14.8	261.5	15.0	267.5	15.1	273.6	15.2	279.7	15.4	285.9	15.5	292.1	15.6	298.4	15.8	304.7	15.9	311.1	16.1	6
7	317.6	16.2	324.1	16.3	330.7	16.5	337.3	16.6	344.0	16.8	350.7	16.9	357.5	17.0	364.3	17.2	371.2	17.3	378.2	17.5	7
8	385.2	17.6	392.3	17.7	399.4	17.9	406.5	18.0	413.8	18.1	421.1	18.3	428.4	18.4	435.8	18.6	443.3	18.7	450.8	18.8	8
9	458.3	19.0	466.0	19.1	473.6	19.3	481.4	19.4	489.1	19.5	497.0	19.7	504.9	19.8	512.8	20.0	520.9	20.1	528.9	20.2	9
10	537.0	20.4	545.2	20.5	553.4	20.6	561.7	20.8	570.1	20.9	578.5	21.1	586.9	21.2	595.4	21.3	604.0	21.5	612.6	21.6	10
11	621.3	21.8	630.0	21.9	638.8	22.0	647.7	22.2	656.6	22.3	665.5	22.5	674.5	22.6	683.6	22.7	692.7	22.9	701.9	23.0	11
12	711.1	23.1	720.4	23.3	729.7	23.4	739.1	23.6	748.6	23.7	758.1	23.8	767.7	24.0	777.3	24.1	787.0	24.3	796.7	24.4	12
13	806.5	24.5	816.3	24.7	826.2	24.8	836.2	25.0	846.2	25.1	856.3	25.2	866.4	25.4	876.5	25.5	886.8	25.6	897.1	25.8	13
14	907.4	25.9	917.8	26.1	928.3	26.2	938.8	26.3	949.3	26.5	960.0	26.6	970.6	26.8	981.4	26.9	992.1	27.0	1003.0	27.2	14
15	1013.9	27.3	1024.8	27.5	1035.9	27.6	1046.9	27.7	1058.0	27.9	1069.2	28.0	1080.4	28.1	1091.7	28.3	1103.1	28.4	1114.5	28.6	15
16	1125.9	28.7	1137.4	28.8	1149.0	29.0	1160.6	29.1	1172.3	29.3	1184.0	29.4	1195.8	29.5	1207.7	29.7	1219.6	29.8	1231.5	30.0	16
17	1243.5	30.1	1255.6	30.2	1267.7	30.4	1279.9	30.5	1292.1	30.6	1304.4	30.8	1316.7	30.9	1329.1	31.1	1341.6	31.2	1354.1	31.3	17
18	1366.7	31.5	1379.3	31.6	1392.0	31.8	1404.7	31.9	1417.5	32.0	1430.3	32.2	1443.2	32.3	1456.2	32.5	1469.2	32.6	1482.3	32.7	18
19	1495.4	32.9	1508.5	33.0	1521.8	33.1	1535.1	33.3	1548.4	33.4	1561.8	33.6	1575.3	33.7	1588.8	33.8	1602.3	34.0	1616.0	34.1	19
20	1629.6	34.3	1643.4	34.4	1657.1	34.5	1671.0	34.7	1684.9	34.8	1698.8	35.0	1712.9	35.1	1726.9	35.2	1741.0	35.4	1755.2	35.5	20
21	1769.4	35.6	1783.7	35.8	1798.1	35.9	1812.5	36.1	1826.9	36.2	1841.4	36.3	1856.0	36.5	1870.6	36.6	1885.3	36.8	1900.0	36.9	21
22	1914.8	37.0	1929.7	37.2	1944.6	37.3	1959.5	37.5	1974.5	37.6	1989.6	37.7	2004.7	37.9	2019.9	38.0	2035.1	38.1	2050.4	38.3	22
23	2065.7	38.4	2081.1	38.6	2096.6	38.7	2112.1	38.8	2127.7	39.0	2143.3	39.1	2159.0	39.3	2174.7	39.4	2190.5	39.5	2206.3	39.7	23
24	2222.2	39.8	2238.2	40.0	2254.2	40.1	2270.3	40.2	2286.4	40.4	2302.5	40.5	2318.8	40.6	2335.1	40.8	2351.4	40.9	2367.8	41.1	24
25	2384.3	41.2	2400.8	41.3	2417.3	41.5	2434.0	41.6	2450.6	41.8	2467.4	41.9	2484.1	42.0	2501.0	42.2	2517.9	42.3	2534.8	42.5	25
26	2551.9	42.6	2568.9	42.7	2586.0	42.9	2603.2	43.0	2620.4	43.1	2637.7	43.3	2655.1	43.4	2672.5	43.6	2689.9	43.7	2707.4	43.8	26
27	2725.0	44.0	2742.6	44.1	2760.3	44.3	2778.0	44.4	2795.8	44.5	2813.7	44.7	2831.6	44.8	2849.5	45.0	2867.5	45.1	2885.6	45.2	27
28	2903.7	45.4	2921.9	45.5	2940.1	45.6	2958.4	45.8	2976.7	45.9	2995.1	46.1	3013.6	46.2	3032.1	46.3	3050.7	46.5	3069.3	46.6	28
29	3088.0	46.8	3106.7	46.9	3125.5	47.0	3144.3	47.2	3163.2	47.3	3182.2	47.5	3201.2	47.6	3220.3	47.7	3239.4	47.9	3258.5	48.0	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 15; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

15

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	*c*
0	0.0	6.9	2.8	7.1	5.7	7.2	8.6	7.4	11.6	7.5	14.6	7.6	17.7	7.8	20.8	7.9	24.0	8.1	27.2	8.2	0
1	30.6	8.3	33.9	8.5	37.3	8.6	40.8	8.8	44.3	8.9	47.9	9.0	51.6	9.2	55.2	9.3	59.0	9.4	62.8	9.6	1
2	66.7	9.7	70.6	9.9	74.6	10.0	78.6	10.1	82.7	10.3	86.8	10.4	91.0	10.6	95.2	10.7	99.6	10.8	103.9	11.0	2
3	108.3	11.1	112.8	11.2	117.3	11.4	121.9	11.5	126.6	11.7	131.2	11.8	136.0	11.9	140.8	12.1	145.7	12.2	150.6	12.4	3
4	155.6	12.5	160.6	12.6	165.7	12.8	170.8	12.9	176.0	13.1	181.2	13.2	186.6	13.3	191.9	13.5	197.3	13.6	202.8	13.8	4
5	208.3	13.9	213.9	14.0	219.6	14.2	225.2	14.3	231.0	14.4	236.8	14.6	242.7	14.7	248.6	14.9	254.6	15.0	260.6	15.1	5
6	266.7	15.3	272.8	15.4	279.0	15.6	285.2	15.7	291.6	15.8	297.9	16.0	304.3	16.1	310.8	16.2	317.3	16.4	323.9	16.5	6
7	330.6	16.7	337.2	16.8	344.0	16.9	350.8	17.1	357.7	17.2	364.6	17.4	371.6	17.5	378.6	17.6	385.7	17.8	392.8	17.9	7
8	400.0	18.1	407.2	18.2	414.6	18.3	421.9	18.5	429.3	18.6	436.8	18.8	444.3	18.9	451.9	19.0	459.6	19.2	467.2	19.3	8
9	475.0	19.4	482.8	19.6	490.7	19.7	498.6	19.9	506.6	20.0	514.6	20.1	522.7	20.3	530.8	20.4	539.0	20.6	547.2	20.7	9
10	555.6	20.8	563.9	21.0	572.3	21.1	580.8	21.2	589.3	21.4	597.9	21.5	606.6	21.7	615.2	21.8	624.0	21.9	632.8	22.1	10
11	641.7	22.2	650.6	22.4	659.6	22.5	668.6	22.6	677.7	22.8	686.8	22.9	696.0	23.1	705.2	23.2	714.6	23.3	723.9	23.5	11
12	733.3	23.6	742.8	23.8	752.3	23.9	761.9	24.0	771.6	24.2	781.2	24.3	791.0	24.4	800.8	24.6	810.7	24.7	820.6	24.9	12
13	830.6	25.0	840.6	25.1	850.7	25.3	860.8	25.4	871.0	25.6	881.2	25.7	891.6	25.8	901.9	26.0	912.3	26.1	922.8	26.2	13
14	933.3	26.4	943.9	26.5	954.6	26.7	965.2	26.8	976.0	26.9	986.8	27.1	997.7	27.2	1008.6	27.4	1019.6	27.5	1030.6	27.6	14
15	1041.7	27.8	1052.8	27.9	1064.0	28.1	1075.2	28.2	1086.6	28.3	1097.9	28.5	1109.3	28.6	1120.8	28.8	1132.3	28.9	1143.9	29.0	15
16	1155.6	29.2	1167.2	29.3	1179.0	29.4	1190.8	29.6	1202.7	29.7	1214.6	29.9	1226.6	30.0	1238.6	30.1	1250.7	30.3	1262.8	30.4	16
17	1275.0	30.6	1287.2	30.7	1299.6	30.8	1311.9	31.0	1324.3	31.1	1336.8	31.2	1349.3	31.4	1361.9	31.5	1374.6	31.7	1387.2	31.8	17
18	1400.0	31.9	1412.8	32.1	1425.7	32.2	1438.6	32.4	1451.6	32.5	1464.6	32.6	1477.7	32.8	1490.8	32.9	1504.0	33.1	1517.2	33.2	18
19	1530.6	33.3	1543.9	33.5	1557.3	33.6	1570.8	33.8	1584.3	33.9	1597.9	34.0	1611.6	34.2	1625.2	34.3	1639.0	34.4	1652.8	34.6	19
20	1666.7	34.7	1680.6	34.9	1694.6	35.0	1708.6	35.1	1722.7	35.3	1736.8	35.4	1751.0	35.6	1765.2	35.7	1779.6	35.8	1793.9	36.0	20
21	1808.3	36.1	1822.8	36.2	1837.3	36.4	1851.9	36.5	1866.6	36.7	1881.2	36.8	1896.0	36.9	1910.8	37.1	1925.7	37.2	1940.6	37.4	21
22	1955.6	37.5	1970.6	37.6	1985.7	37.8	2000.8	37.9	2016.0	38.1	2031.2	38.2	2046.6	38.3	2061.9	38.5	2077.3	38.6	2092.8	38.8	22
23	2108.3	38.9	2123.9	39.0	2139.6	39.2	2155.2	39.3	2171.0	39.4	2186.8	39.6	2202.7	39.7	2218.6	39.9	2234.6	40.0	2250.6	40.1	23
24	2266.7	40.3	2282.8	40.4	2299.0	40.6	2315.2	40.7	2331.6	40.8	2347.9	41.0	2364.3	41.1	2380.8	41.2	2397.3	41.4	2413.9	41.5	24
25	2430.6	41.7	2447.2	41.8	2464.0	41.9	2480.8	42.1	2497.7	42.2	2514.6	42.4	2531.6	42.5	2548.6	42.6	2565.7	42.8	2582.8	42.9	25
26	2600.0	43.1	2617.2	43.2	2634.6	43.3	2651.9	43.5	2669.3	43.6	2686.8	43.8	2704.3	43.9	2721.9	44.0	2739.6	44.2	2757.2	44.3	26
27	2775.0	44.4	2792.8	44.6	2810.7	44.7	2828.6	44.9	2846.6	45.0	2864.6	45.1	2882.7	45.3	2900.8	45.4	2919.0	45.6	2937.2	45.7	27
28	2955.6	45.8	2973.9	46.0	2992.3	46.1	3010.8	46.2	3029.3	46.4	3047.9	46.5	3066.6	46.7	3085.2	46.8	3104.0	46.9	3122.8	47.1	28
29	3141.7	47.2	3160.6	47.4	3179.6	47.5	3198.6	47.6	3217.7	47.8	3236.8	47.9	3256.0	48.1	3275.2	48.2	3294.6	48.3	3313.9	48.5	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 16; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	.0		.1		.2		.3		.4	16	.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	7.4	3.0	7.5	6.0	7.7	9.1	7.8	12.3	8.0	15.5	8.1	18.8	8.2	22.1	8.4	25.5	8.5	28.9	8.7	0
1	32.4	8.8	36.0	8.9	39.6	9.1	43.2	9.2	46.9	9.4	50.7	9.5	54.5	9.6	58.4	9.8	62.3	9.9	66.3	10.0	1
2	70.4	10.2	74.5	10.3	78.6	10.5	82.8	10.6	87.1	10.7	91.4	10.9	95.8	11.0	100.2	11.2	104.7	11.3	109.3	11.4	2
3	113.9	11.6	118.5	11.7	123.3	11.9	128.0	12.0	132.9	12.1	137.7	12.3	142.7	12.4	147.7	12.5	152.7	12.7	157.8	12.8	3
4	163.0	13.0	168.2	13.1	173.4	13.2	178.8	13.4	184.1	13.5	189.6	13.7	195.1	13.8	200.6	13.9	206.2	14.1	211.9	14.2	4
5	217.6	14.4	223.4	14.5	229.2	14.6	235.1	14.8	241.0	14.9	247.0	15.0	253.0	15.2	259.1	15.3	265.3	15.5	271.5	15.6	5
6	277.8	15.7	284.1	15.9	290.5	16.0	296.9	16.2	303.4	16.3	310.0	16.4	316.6	16.6	323.2	16.7	329.9	16.9	336.7	17.0	6
7	343.5	17.1	350.4	17.3	357.3	17.4	364.3	17.5	371.4	17.7	378.5	17.8	385.6	18.0	392.8	18.1	400.1	18.2	407.4	18.4	7
8	414.8	18.5	422.2	18.7	429.7	18.8	437.3	18.9	444.9	19.1	452.5	19.2	460.3	19.4	468.0	19.5	475.9	19.6	483.7	19.8	8
9	491.7	19.9	499.7	20.0	507.7	20.2	515.8	20.3	524.0	20.5	532.2	20.6	540.4	20.7	548.8	20.9	557.1	21.0	565.6	21.2	9
10	574.1	21.3	582.6	21.4	591.2	21.6	599.9	21.7	608.6	21.9	617.4	22.0	626.2	22.1	635.1	22.3	644.0	22.4	653.0	22.5	10
11	662.0	22.7	671.1	22.8	680.3	23.0	689.5	23.1	698.8	23.2	708.1	23.4	717.5	23.5	726.9	23.7	736.4	23.8	746.0	23.9	11
12	755.6	24.1	765.2	24.2	774.9	24.4	784.7	24.5	794.5	24.6	804.4	24.8	814.3	24.9	824.3	25.0	834.4	25.2	844.5	25.3	12
13	854.6	25.5	864.8	25.6	875.1	25.7	885.4	25.9	895.8	26.0	906.2	26.2	916.7	26.3	927.3	26.4	937.9	26.6	948.5	26.7	13
14	959.3	26.9	970.0	27.0	980.9	27.1	991.7	27.3	1002.7	27.4	1013.7	27.5	1024.7	27.7	1035.8	27.8	1047.0	28.0	1058.2	28.1	14
15	1069.4	28.2	1080.8	28.4	1092.1	28.5	1103.6	28.7	1115.1	28.8	1126.6	28.9	1138.2	29.1	1149.9	29.2	1161.6	29.4	1173.4	29.5	15
16	1185.2	29.6	1197.1	29.8	1209.0	29.9	1221.0	30.0	1233.0	30.2	1245.1	30.3	1257.3	30.5	1269.5	30.6	1281.8	30.7	1294.1	30.9	16
17	1306.5	31.0	1318.9	31.2	1331.4	31.3	1344.0	31.4	1356.6	31.6	1369.2	31.7	1381.9	31.9	1394.7	32.0	1407.5	32.1	1420.4	32.3	17
18	1433.3	32.4	1446.3	32.5	1459.4	32.7	1472.5	32.8	1485.6	33.0	1498.8	33.1	1512.1	33.2	1525.4	33.4	1538.8	33.5	1552.2	33.7	18
19	1565.7	33.8	1579.3	33.9	1592.9	34.1	1606.5	34.2	1620.3	34.4	1634.0	34.5	1647.9	34.6	1661.7	34.8	1675.7	34.9	1689.7	35.0	19
20	1703.7	35.2	1717.8	35.3	1732.0	35.5	1746.2	35.6	1760.4	35.7	1774.8	35.9	1789.1	36.0	1803.6	36.2	1818.1	36.3	1832.6	36.4	20
21	1847.2	36.6	1861.9	36.7	1876.6	36.9	1891.4	37.0	1906.2	37.1	1921.1	37.3	1936.0	37.4	1951.0	37.5	1966.0	37.7	1981.1	37.8	21
22	1996.3	38.0	2011.5	38.1	2026.8	38.2	2042.1	38.4	2057.5	38.5	2072.9	38.7	2088.4	38.8	2104.0	38.9	2119.6	39.1	2135.2	39.2	22
23	2150.9	39.4	2166.7	39.5	2182.5	39.6	2198.4	39.8	2214.3	39.9	2230.3	40.0	2246.4	40.2	2262.5	40.3	2278.6	40.5	2294.8	40.6	23
24	2311.1	40.7	2327.4	40.9	2343.8	41.0	2360.2	41.2	2376.7	41.3	2393.3	41.4	2409.9	41.6	2426.5	41.7	2443.3	41.9	2460.0	42.0	24
25	2476.9	42.1	2493.7	42.3	2510.7	42.4	2527.7	42.5	2544.7	42.7	2561.8	42.8	2579.0	43.0	2596.2	43.1	2613.4	43.2	2630.8	43.4	25
26	2648.1	43.5	2665.6	43.7	2683.1	43.8	2700.6	43.9	2718.2	44.1	2735.9	44.2	2753.6	44.4	2771.4	44.5	2789.2	44.6	2807.1	44.8	26
27	2825.0	44.9	2843.0	45.0	2861.0	45.2	2879.1	45.3	2897.3	45.5	2915.5	45.6	2933.8	45.7	2952.1	45.9	2970.5	46.0	2988.9	46.2	27
28	3007.4	46.3	3026.0	46.4	3044.6	46.6	3063.2	46.7	3081.9	46.9	3100.7	47.0	3119.5	47.1	3138.4	47.3	3157.3	47.4	3176.3	47.5	28
29	3195.4	47.7	3214.5	47.8	3233.6	48.0	3252.8	48.1	3272.1	48.2	3291.4	48.4	3310.8	48.5	3330.2	48.7	3349.7	48.8	3369.3	48.9	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 18; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	18																				
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	8.3	3.4	8.5	6.8	8.6	10.2	8.8	13.8	8.9	17.4	9.0	21.0	9.2	24.7	9.3	28.4	9.4	32.2	9.6	0
1	36.1	9.7	40.0	9.9	44.0	10.0	48.0	10.1	52.1	10.3	56.2	10.4	60.4	10.6	64.7	10.7	69.0	10.8	73.4	11.0	1
2	77.8	11.1	82.2	11.2	86.8	11.4	91.4	11.5	96.0	11.7	100.7	11.8	105.4	11.9	110.2	12.1	115.1	12.2	120.0	12.4	2
3	125.0	12.5	130.0	12.6	135.1	12.8	140.2	12.9	145.4	13.1	150.7	13.2	156.0	13.3	161.4	13.5	166.8	13.6	172.2	13.8	3
4	177.8	13.9	183.4	14.0	189.0	14.2	194.7	14.3	200.4	14.4	206.2	14.6	212.1	14.7	218.0	14.9	224.0	15.0	230.0	15.1	4
5	236.1	15.3	242.2	15.4	248.4	15.6	254.7	15.7	261.0	15.8	267.4	16.0	273.8	16.1	280.2	16.2	286.8	16.4	293.4	16.5	5
6	300.0	16.7	306.7	16.8	313.4	16.9	320.2	17.1	327.1	17.2	334.0	17.4	341.0	17.5	348.0	17.6	355.1	17.8	362.2	17.9	6
7	369.4	18.1	376.7	18.2	384.0	18.3	391.4	18.5	398.8	18.6	406.2	18.8	413.8	18.9	421.4	19.0	429.0	19.2	436.7	19.3	7
8	444.4	19.4	452.2	19.6	460.1	19.7	468.0	19.9	476.0	20.0	484.0	20.1	492.1	20.3	500.2	20.4	508.4	20.6	516.7	20.7	8
9	525.0	20.8	533.4	21.0	541.8	21.1	550.2	21.2	558.8	21.4	567.4	21.5	576.0	21.7	584.7	21.8	593.4	21.9	602.2	22.1	9
10	611.1	22.2	620.0	22.4	629.0	22.5	638.0	22.6	647.1	22.8	656.2	22.9	665.4	23.1	674.7	23.2	684.0	23.3	693.4	23.5	10
11	702.8	23.6	712.2	23.8	721.8	23.9	731.4	24.0	741.0	24.2	750.7	24.3	760.4	24.4	770.2	24.6	780.1	24.7	790.0	24.9	11
12	800.0	25.0	810.0	25.1	820.1	25.3	830.2	25.4	840.4	25.6	850.7	25.7	861.0	25.8	871.4	26.0	881.8	26.1	892.2	26.2	12
13	902.8	26.4	913.4	26.5	924.0	26.7	934.7	26.8	945.4	26.9	956.2	27.1	967.1	27.2	978.0	27.4	989.0	27.5	1000.0	27.6	13
14	1011.1	27.8	1022.2	27.9	1033.4	28.1	1044.7	28.2	1056.0	28.3	1067.4	28.5	1078.8	28.6	1090.2	28.8	1101.8	28.9	1113.4	29.0	14
15	1125.0	29.2	1136.7	29.3	1148.4	29.4	1160.2	29.6	1172.1	29.7	1184.0	29.9	1196.0	30.0	1208.0	30.1	1220.1	30.3	1232.2	30.4	15
16	1244.4	30.6	1256.7	30.7	1269.0	30.8	1281.4	31.0	1293.8	31.1	1306.2	31.2	1318.8	31.4	1331.4	31.5	1344.0	31.7	1356.7	31.8	16
17	1369.4	31.9	1382.2	32.1	1395.1	32.2	1408.0	32.4	1421.0	32.5	1434.0	32.6	1447.1	32.8	1460.2	32.9	1473.4	33.1	1486.7	33.2	17
18	1500.0	33.3	1513.4	33.5	1526.8	33.6	1540.2	33.8	1553.8	33.9	1567.4	34.0	1581.0	34.2	1594.7	34.3	1608.4	34.4	1622.2	34.6	18
19	1636.1	34.7	1650.0	34.9	1664.0	35.0	1678.0	35.1	1692.1	35.3	1706.2	35.4	1720.4	35.6	1734.7	35.7	1749.0	35.8	1763.4	36.0	19
20	1777.8	36.1	1792.2	36.2	1806.8	36.4	1821.4	36.5	1836.0	36.7	1850.7	36.8	1865.4	36.9	1880.2	37.1	1895.1	37.2	1910.0	37.4	20
21	1925.0	37.5	1940.0	37.6	1955.1	37.8	1970.2	37.9	1985.4	38.1	2000.7	38.2	2016.0	38.3	2031.4	38.5	2046.8	38.6	2062.2	38.8	21
22	2077.8	38.9	2093.4	39.0	2109.0	39.2	2124.7	39.3	2140.4	39.4	2156.2	39.6	2172.1	39.7	2188.0	39.9	2204.0	40.0	2220.0	40.1	22
23	2236.1	40.3	2252.2	40.4	2268.4	40.6	2284.7	40.7	2301.0	40.8	2317.4	41.0	2333.8	41.1	2350.2	41.2	2366.8	41.4	2383.4	41.5	23
24	2400.0	41.7	2416.7	41.8	2433.4	41.9	2450.2	42.1	2467.1	42.2	2484.0	42.4	2501.0	42.5	2518.0	42.6	2535.1	42.8	2552.2	42.9	24
25	2569.4	43.1	2586.7	43.2	2604.0	43.3	2621.4	43.5	2638.8	43.6	2656.2	43.8	2673.8	43.9	2691.4	44.0	2709.0	44.2	2726.7	44.3	25
26	2744.4	44.4	2762.2	44.6	2780.1	44.7	2798.0	44.9	2816.0	45.0	2834.0	45.1	2852.1	45.3	2870.2	45.4	2888.4	45.6	2906.7	45.7	26
27	2925.0	45.8	2942.4	46.0	2961.8	46.1	2980.2	46.2	2998.8	46.4	3017.4	46.5	3036.0	46.7	3054.7	46.8	3073.4	46.9	3092.2	47.1	27
28	3111.1	47.2	3130.0	47.4	3149.0	47.5	3168.0	47.6	3187.1	47.8	3206.2	47.9	3225.4	48.1	3244.7	48.2	3264.0	48.3	3283.4	48.5	28
29	3302.8	48.6	3322.2	48.8	3341.8	48.9	3361.4	49.0	3381.0	49.2	3400.7	49.3	3420.4	49.4	3440.2	49.6	3460.1	49.7	3480.0	49.9	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 20: SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

20

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	9.3	3.7	9.4	7.5	9.5	11.4	9.7	15.3	9.8	19.2	10.0	23.2	10.1	27.3	10.2	31.4	10.4	35.6	10.5	0
1	39.8	10.6	44.1	10.8	48.4	10.9	52.8	11.1	57.3	11.2	61.8	11.3	66.4	11.5	71.0	11.6	75.7	11.8	80.4	11.9	1
2	85.2	12.0	90.0	12.2	94.9	12.3	99.9	12.5	104.9	12.6	110.0	12.7	115.1	12.9	120.2	13.0	125.5	13.1	130.8	13.3	2
3	136.1	13.4	141.5	13.6	147.0	13.7	152.5	13.8	158.0	14.0	163.7	14.1	169.3	14.3	175.1	14.4	180.9	14.5	186.7	14.7	3
4	192.6	14.8	198.5	15.0	204.6	15.1	210.6	15.2	216.7	15.4	222.9	15.5	229.1	15.6	235.4	15.8	241.8	15.9	248.2	16.1	4
5	254.6	16.2	261.1	16.3	267.7	16.5	274.3	16.6	281.0	16.8	287.7	16.9	294.5	17.0	301.4	17.2	308.3	17.3	315.2	17.5	5
6	322.2	17.6	329.3	17.7	336.4	17.9	343.6	18.0	350.8	18.1	358.1	18.3	365.4	18.4	372.8	18.6	380.3	18.7	387.8	18.8	6
7	395.4	19.0	403.0	19.1	410.7	19.3	418.4	19.4	426.2	19.5	434.0	19.7	441.9	19.8	449.9	20.0	457.9	20.1	466.0	20.2	7
8	474.1	20.4	482.2	20.5	490.5	20.6	498.8	20.8	507.1	20.9	515.5	21.1	524.0	21.2	532.5	21.3	541.0	21.5	549.7	21.6	8
9	558.3	21.8	567.1	21.9	575.9	22.0	584.7	22.2	593.6	22.3	602.5	22.5	611.6	22.6	620.6	22.7	629.7	22.9	638.9	23.0	9
10	648.1	23.1	657.4	23.3	666.8	23.4	676.2	23.6	685.6	23.7	695.1	23.8	704.7	24.0	714.3	24.1	724.0	24.3	733.7	24.4	10
11	743.5	24.5	753.4	24.7	763.3	24.8	773.2	25.0	783.2	25.1	793.3	25.2	803.4	25.4	813.6	25.5	823.8	25.6	834.1	25.8	11
12	844.4	25.9	854.8	26.1	865.3	26.2	875.8	26.3	886.4	26.5	897.0	26.6	907.7	26.8	918.4	26.9	929.2	27.0	940.0	27.2	12
13	950.9	27.3	961.9	27.5	972.9	27.6	984.0	27.7	995.1	27.9	1006.2	28.0	1017.5	28.1	1028.8	28.3	1040.1	28.4	1051.5	28.6	13
14	1063.0	28.7	1074.5	28.8	1086.0	29.0	1097.7	29.1	1109.3	29.3	1121.1	29.4	1132.9	29.5	1144.7	29.7	1156.6	29.8	1168.5	30.0	14
15	1180.6	30.1	1192.6	30.2	1204.7	30.4	1216.9	30.5	1229.1	30.6	1241.4	30.8	1253.8	30.9	1266.2	31.1	1278.6	31.2	1291.1	31.3	15
16	1303.7	31.5	1316.3	31.6	1329.0	31.8	1341.7	31.9	1354.5	32.0	1367.4	32.2	1380.3	32.3	1393.2	32.5	1406.2	32.6	1419.3	32.7	16
17	1432.4	32.9	1445.6	33.0	1458.8	33.1	1472.1	33.3	1485.4	33.4	1498.8	33.6	1512.3	33.7	1525.8	33.8	1539.4	34.0	1553.0	34.1	17
18	1566.7	34.3	1580.4	34.4	1594.2	34.5	1608.0	34.7	1621.9	34.8	1635.9	35.0	1649.9	35.1	1664.0	35.2	1678.1	35.4	1692.2	35.5	18
19	1706.5	35.6	1720.8	35.8	1735.1	35.9	1749.5	36.1	1764.0	36.2	1778.5	36.3	1793.0	36.5	1807.7	36.6	1822.3	36.8	1837.1	36.9	19
20	1851.9	37.0	1866.7	37.2	1881.	37.3	1896.5	37.5	1911.6	37.6	1926.6	37.7	1941.7	37.9	1956.9	38.0	1972.1	38.1	1987.4	38.3	20
21	2002.8	38.4	2018.2	38.6	2033.6	38.7	2049.1	38.8	2064.7	39.0	2080.3	39.1	2096.0	39.3	2111.7	39.4	2127.5	39.5	2143.4	39.7	21
22	2159.3	39.8	2175.2	40.0	2191.2	40.1	2207.3	40.2	2223.4	40.4	2239.6	40.5	2255.8	40.6	2272.1	40.8	2288.4	40.9	2304.8	41.1	22
23	2321.3	41.2	2337.8	41.3	2354.4	41.5	2371.0	41.6	2387.7	41.8	2404.4	41.9	2421.2	42.0	2438.0	42.2	2454.9	42.3	2471.9	42.5	23
24	2488.9	42.6	2506.0	42.7	2523.1	42.9	2540.2	43.0	2557.5	43.1	2574.8	43.3	2592.1	43.4	2609.5	43.6	2627.0	43.7	2644.5	43.8	24
25	2662.0	44.0	2679.7	44.1	2697.3	44.3	2715.1	44.4	2732.9	44.5	2750.7	44.7	2768.6	44.8	2786.5	45.0	2804.6	45.1	2822.6	45.2	25
26	2840.7	45.4	2858.9	45.5	2877.1	45.6	2895.4	45.8	2913.8	45.9	2932.2	46.1	2950.6	46.2	2969.1	46.3	2987.7	46.5	3006.3	46.6	26
27	3025.0	46.8	3043.7	46.9	3062.5	47.0	3081.4	47.2	3100.3	47.3	3119.2	47.5	3138.2	47.6	3157.3	47.7	3176.4	47.9	3195.6	48.0	27
28	3214.8	48.1	3234.1	48.3	3253.4	48.4	3272.8	48.6	3292.3	48.7	3311.8	48.8	3331.4	49.0	3351.0	49.1	3370.7	49.3	3390.4	49.4	28
29	3410.2	49.5	3430.0	49.7	3449.9	49.8	3469.9	50.0	3489.9	50.1	3510.0	50.2	3530.1	50.4	3550.2	50.5	3570.5	50.6	3590.8	50.8	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 21; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	9.7	3.9	9.9	7.9	10.0	11.9	10.1	16.0	10.3	20.1	10.4	24.3	10.6	28.6	10.7	32.9	10.8	37.2	11.0	0
1	41.7	11.1	46.1	11.2	50.7	11.4	55.2	11.5	59.9	11.7	64.6	11.8	69.3	11.9	74.1	12.1	79.0	12.2	83.9	12.4	1
2	88.9	12.5	93.9	12.6	99.0	12.8	104.1	12.9	109.3	13.1	114.6	13.2	119.9	13.3	125.2	13.5	130.7	13.6	136.1	13.8	2
3	141.7	13.9	147.2	14.0	152.9	14.2	158.6	14.3	164.3	14.4	170.1	14.6	176.0	14.7	181.9	14.9	187.9	15.0	193.9	15.1	3
4	200.0	15.3	206.1	15.4	212.3	15.6	218.6	15.7	224.9	15.8	231.2	16.0	237.7	16.1	244.1	16.2	250.7	16.4	257.2	16.5	4
5	263.9	16.7	270.6	16.8	277.3	16.9	284.1	17.1	291.0	17.2	297.9	17.4	304.9	17.5	311.9	17.6	319.0	17.8	326.1	17.9	5
6	333.3	18.1	340.6	18.2	347.9	18.3	355.2	18.5	362.7	18.6	370.1	18.8	377.7	18.9	385.2	19.0	392.9	19.2	400.6	19.3	6
7	408.3	19.4	416.1	19.6	424.0	19.7	431.9	19.9	439.9	20.0	447.9	20.1	456.0	20.3	464.1	20.4	472.3	20.6	480.6	20.7	7
8	488.9	20.8	497.2	21.0	505.7	21.1	514.1	21.2	522.7	21.4	531.2	21.5	539.9	21.7	548.6	21.8	557.3	21.9	566.1	22.1	8
9	575.0	22.2	583.9	22.4	592.9	22.5	601.9	22.6	611.0	22.8	620.1	22.9	629.3	23.1	638.6	23.2	647.9	23.3	657.2	23.5	9
10	666.7	23.6	676.1	23.8	685.7	23.9	695.2	24.0	704.9	24.2	714.6	24.3	724.3	24.4	734.1	24.6	744.0	24.7	753.9	24.9	10
11	763.9	25.0	773.9	25.1	784.0	25.3	794.1	25.4	804.3	25.6	814.6	25.7	824.9	25.8	835.2	26.0	845.7	26.1	856.1	26.2	11
12	866.7	26.4	877.2	26.5	887.9	26.7	898.6	26.8	909.3	26.9	920.1	27.1	931.0	27.2	941.9	27.4	952.9	27.5	963.9	27.6	12
13	975.0	27.8	986.1	27.9	997.3	28.1	1008.6	28.2	1019.9	28.3	1031.2	28.5	1042.7	28.6	1054.1	28.8	1065.7	28.9	1077.2	29.0	13
14	1088.9	29.2	1100.6	29.3	1112.3	29.4	1124.1	29.6	1136.0	29.7	1147.9	29.9	1159.9	30.0	1171.9	30.1	1184.0	30.3	1196.1	30.4	14
15	1208.3	30.6	1220.6	30.7	1232.9	30.8	1245.2	31.0	1257.7	31.1	1270.1	31.2	1282.7	31.4	1295.2	31.5	1307.9	31.7	1320.6	31.8	15
16	1333.3	31.9	1346.1	32.1	1359.0	32.2	1371.9	32.4	1384.9	32.5	1397.9	32.6	1411.0	32.8	1424.1	32.9	1437.3	33.1	1450.6	33.2	16
17	1463.9	33.3	1477.2	33.5	1490.7	33.6	1504.1	33.8	1517.7	33.9	1531.2	34.0	1544.9	34.2	1558.6	34.3	1572.3	34.4	1586.1	34.6	17
18	1600.0	34.7	1613.9	34.9	1627.9	35.0	1641.9	35.1	1656.0	35.3	1670.1	35.4	1684.3	35.6	1698.6	35.7	1712.9	35.8	1727.2	36.0	18
19	1741.7	36.1	1756.1	36.2	1770.7	36.4	1785.2	36.5	1799.9	36.7	1814.6	36.8	1829.3	36.9	1844.1	37.1	1859.0	37.2	1873.9	37.4	19
20	1888.9	37.5	1903.9	37.6	1919.0	37.8	1934.1	37.9	1949.3	38.1	1964.6	38.2	1979.9	38.3	1995.2	38.5	2010.7	38.6	2026.1	38.8	20
21	2041.7	38.9	2057.2	39.0	2072.9	39.2	2088.6	39.3	2104.3	39.4	2120.1	39.6	2136.0	39.7	2151.9	39.9	2167.9	40.0	2183.9	40.1	21
22	2200.0	40.3	2216.1	40.4	2232.3	40.6	2248.6	40.7	2264.9	40.8	2281.2	41.0	2297.7	41.1	2314.1	41.2	2330.7	41.4	2347.2	41.5	22
23	2363.9	41.7	2380.6	41.8	2397.3	41.9	2414.1	42.1	2431.0	42.2	2447.9	42.4	2464.9	42.5	2481.9	42.6	2499.0	42.8	2516.1	42.9	23
24	2533.3	43.1	2550.6	43.2	2567.9	43.3	2585.2	43.5	2602.7	43.6	2620.1	43.8	2637.7	43.9	2655.2	44.0	2672.9	44.2	2690.6	44.3	24
25	2708.3	44.4	2726.1	44.6	2744.0	44.7	2761.9	44.9	2779.9	45.0	2797.9	45.1	2816.0	45.3	2834.1	45.4	2852.3	45.6	2870.6	45.7	25
26	2888.9	45.8	2907.2	46.0	2925.7	46.1	2944.1	46.2	2962.7	46.4	2981.2	46.5	2999.9	46.7	3018.6	46.8	3037.3	46.9	3056.1	47.1	26
27	3075.0	47.2	3093.9	47.4	3112.9	47.5	3131.9	47.6	3151.0	47.8	3170.1	47.9	3189.3	48.1	3208.6	48.2	3227.9	48.3	3247.2	48.5	27
28	3266.7	48.6	3286.1	48.8	3305.7	48.9	3325.2	49.0	3344.9	49.2	3364.6	49.3	3384.3	49.4	3404.1	49.6	3424.0	49.7	3443.9	49.9	28
29	3463.9	50.0	3483.9	50.1	3504.0	50.3	3524.1	50.4	3544.3	50.6	3564.6	50.7	3584.9	50.8	3605.2	51.0	3625.7	51.1	3646.1	51.2	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

21

TABLE XXXII.—BASE 22; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

22

c	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		c
	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	
0	0.0	10.2	4.1	10.3	8.3	10.5	12.5	10.6	16.7	10.7	21.1	10.9	25.4	11.0	29.9	11.2	34.4	11.3	38.9	11.4	0
1	43.5	11.6	48.2	11.7	52.9	11.9	57.7	12.0	62.5	12.1	67.4	12.3	72.3	12.4	77.3	12.5	82.3	12.7	87.4	12.8	1
2	92.6	13.0	97.8	13.1	103.1	13.2	108.4	13.4	113.8	13.5	119.2	13.7	124.7	13.8	130.2	13.9	135.9	14.1	141.5	14.2	2
3	147.2	14.4	153.0	14.5	158.8	14.6	164.7	14.8	170.6	14.9	176.6	15.0	182.7	15.2	188.8	15.3	194.9	15.5	201.1	15.6	3
4	207.4	15.7	213.7	15.9	220.1	16.0	226.5	16.2	233.0	16.3	239.6	16.4	246.2	16.6	252.8	16.7	259.6	16.9	266.3	17.0	4
5	273.1	17.1	280.0	17.3	287.0	17.4	294.0	17.5	301.0	17.7	308.1	17.8	315.3	18.0	322.5	18.1	329.7	18.2	337.1	18.4	5
6	344.4	18.5	351.9	18.7	359.4	18.8	366.9	18.9	374.5	19.1	382.2	19.2	389.9	19.4	397.7	19.5	405.5	19.6	413.4	19.8	6
7	421.3	19.9	429.3	20.0	437.3	20.2	445.4	20.3	453.6	20.5	461.8	20.6	470.1	20.7	478.4	20.9	486.8	21.0	495.2	21.2	7
8	503.7	21.3	512.2	21.4	520.9	21.6	529.5	21.7	538.2	21.9	547.0	22.0	555.8	22.1	564.7	22.3	573.6	22.4	582.6	22.5	8
9	591.7	22.7	600.8	22.8	609.9	23.0	619.1	23.1	628.4	23.2	637.7	23.4	647.1	23.5	656.5	23.7	666.0	23.8	675.6	23.9	9
10	685.2	24.1	694.8	24.2	704.6	24.4	714.3	24.5	724.1	24.6	734.0	24.8	744.0	24.9	754.0	25.0	764.0	25.2	774.1	25.3	10
11	784.3	25.5	794.5	25.6	804.7	25.7	815.1	25.9	825.4	26.0	835.9	26.2	846.4	26.3	856.9	26.4	867.5	26.6	878.2	26.7	11
12	888.9	26.9	899.7	27.0	910.5	27.1	921.4	27.3	932.3	27.4	943.3	27.5	954.3	27.7	965.4	27.8	976.6	28.0	987.8	28.1	12
13	999.1	28.2	1010.4	28.4	1021.8	28.5	1033.2	28.7	1044.7	28.8	1056.2	28.9	1067.9	29.1	1079.5	29.2	1091.2	29.4	1103.0	29.5	13
14	1114.8	29.6	1126.7	29.8	1138.6	29.9	1150.6	30.0	1162.7	30.2	1174.8	30.3	1186.9	30.5	1199.1	30.6	1211.4	30.7	1223.7	30.9	14
15	1236.1	31.0	1248.5	31.2	1261.0	31.3	1273.6	31.4	1286.2	31.6	1298.8	31.7	1311.6	31.9	1324.3	32.0	1337.1	32.1	1350.0	32.3	15
16	1363.0	32.4	1376.0	32.5	1389.0	32.7	1402.1	32.8	1415.3	33.0	1428.5	33.1	1441.7	33.2	1455.1	33.4	1468.4	33.5	1481.9	33.7	16
17	1495.4	33.8	1508.9	33.9	1522.5	34.1	1536.2	34.2	1549.9	34.4	1563.7	34.5	1577.5	34.6	1591.4	34.8	1605.3	34.9	1619.3	35.0	17
18	1633.3	35.2	1647.4	35.3	1661.6	35.5	1675.8	35.6	1690.1	35.7	1704.4	35.9	1718.8	36.0	1733.2	36.2	1747.7	36.3	1762.2	36.4	18
19	1776.9	36.6	1791.5	36.7	1806.2	36.9	1821.0	37.0	1835.8	37.1	1850.7	37.3	1865.6	37.4	1880.6	37.5	1895.7	37.7	1910.8	37.8	19
20	1925.9	38.0	1941.1	38.1	1956.4	38.2	1971.7	38.4	1987.1	38.5	2002.5	38.7	2018.0	38.8	2033.6	38.9	2049.2	39.1	2064.8	39.2	20
21	2080.6	39.4	2096.3	39.5	2112.1	39.6	2128.0	39.8	2144.0	39.9	2160.0	40.0	2176.0	40.2	2192.1	40.3	2208.3	40.5	2224.5	40.6	21
22	2240.7	40.7	2257.1	40.9	2273.4	41.0	2289.9	41.2	2306.4	41.3	2322.9	41.4	2339.5	41.6	2356.2	41.7	2372.9	41.9	2389.7	42.0	22
23	2406.5	42.1	2423.4	42.3	2440.3	42.4	2457.3	42.5	2474.3	42.7	2491.4	42.8	2508.6	43.0	2525.8	43.1	2543.1	43.2	2560.4	43.4	23
24	2577.8	43.5	2595.2	43.7	2612.7	43.8	2630.2	43.9	2647.9	44.1	2665.5	44.2	2683.2	44.4	2701.0	44.5	2718.8	44.6	2736.7	44.8	24
25	2754.6	44.9	2772.6	45.0	2790.7	45.2	2808.8	45.3	2826.9	45.5	2845.1	45.6	2863.4	45.7	2881.7	45.9	2900.1	46.0	2918.5	46.2	25
26	2937.0	46.3	2955.6	46.4	2974.2	46.6	2992.8	46.7	3011.6	46.9	3030.3	47.0	3049.1	47.1	3068.0	47.3	3087.0	47.4	3106.0	47.5	26
27	3125.0	47.7	3144.1	47.8	3163.3	48.0	3182.5	48.1	3201.7	48.2	3221.1	48.4	3240.4	48.5	3259.9	48.7	3279.4	48.8	3298.9	48.9	27
28	3318.5	49.1	3338.2	49.2	3357.9	49.4	3377.7	49.5	3397.5	49.6	3417.4	49.8	3437.3	49.9	3457.3	50.0	3477.3	50.2	3497.4	50.3	28
29	3517.6	50.5	3537.8	50.6	3558.1	50.7	3578.4	50.9	3598.8	51.0	3619.2	51.2	3639.7	51.3	3660.2	51.4	3680.9	51.6	3701.5	51.7	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 23; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

23

c	.0 L.	.0 K.	.1 L.	.1 K.	.2 L.	.2 K.	.3 L.	.3 K.	.4 L.	.4 K.	.5 L.	.5 K.	.6 L.	.6 K.	.7 L.	.7 K.	.8 L.	.8 K.	.9 L.	.9 K.	c
0	0.0	10.6	4.3	10.8	8.6	10.9	13.0	11.1	17.5	11.2	22.0	11.3	26.6	11.5	31.2	11.6	35.9	11.8	40.6	11.9	0
1	45.4	12.0	50.2	12.2	55.1	12.3	60.1	12.5	65.1	12.6	70.1	12.7	75.3	12.9	80.4	13.0	85.7	13.1	91.0	13.3	1
2	96.3	13.4	101.7	13.6	107.1	13.7	112.7	13.8	118.2	14.0	123.8	14.1	129.5	14.3	135.2	14.4	141.0	14.5	146.9	14.7	2
3	152.8	14.8	158.7	15.0	164.7	15.1	170.8	15.2	176.9	15.4	183.1	15.5	189.3	15.6	195.6	15.8	202.0	15.9	208.4	16.1	3
4	214.8	16.2	221.3	16.3	227.9	16.5	234.5	16.6	241.2	16.8	247.9	16.9	254.7	17.0	261.5	17.2	268.4	17.3	275.4	17.5	4
5	282.4	17.6	289.5	17.7	296.6	17.9	303.8	18.0	311.0	18.1	318.3	18.3	325.6	18.4	333.0	18.6	340.5	18.7	348.0	18.8	5
6	355.6	19.0	363.2	19.1	370.9	19.3	378.6	19.4	386.4	19.5	394.2	19.7	402.1	19.8	410.1	20.0	418.1	20.1	426.1	20.2	6
7	434.3	20.4	442.4	20.5	450.7	20.6	459.0	20.8	467.3	20.9	475.7	21.1	484.1	21.2	492.7	21.3	501.2	21.5	509.8	21.6	7
8	518.5	21.8	527.2	21.9	536.0	22.0	544.9	22.2	553.8	22.3	562.7	22.5	571.7	22.6	580.8	22.7	589.9	22.9	599.1	23.0	8
9	608.3	23.1	617.6	23.3	627.0	23.4	636.4	23.6	645.8	23.7	655.3	23.8	664.9	24.0	674.5	24.1	684.2	24.3	693.9	24.4	9
10	703.7	24.5	713.5	24.7	723.4	24.8	733.4	25.0	743.4	25.1	753.5	25.2	763.6	25.4	773.8	25.5	784.0	25.6	794.3	25.8	10
11	804.6	25.9	815.0	26.1	825.5	26.2	836.0	26.3	846.6	26.5	857.2	26.6	867.9	26.8	878.6	26.9	889.4	27.0	900.2	27.2	11
12	911.1	27.3	922.1	27.5	933.1	27.6	944.1	27.7	955.3	27.9	966.4	28.0	977.7	28.1	989.0	28.3	1000.3	28.4	1011.7	28.6	12
13	1023.1	28.7	1034.7	28.8	1046.2	29.0	1057.8	29.1	1069.5	29.3	1081.2	29.4	1093.0	29.5	1104.9	29.7	1116.8	29.8	1128.7	30.0	13
14	1140.7	30.1	1152.8	30.2	1164.9	30.4	1177.1	30.5	1189.3	30.6	1201.6	30.8	1214.0	30.9	1226.4	31.1	1238.8	31.2	1251.3	31.3	14
15	1263.9	31.5	1276.5	31.6	1289.2	31.8	1301.9	31.9	1314.7	32.0	1327.5	32.2	1340.4	32.3	1353.4	32.5	1366.4	32.6	1379.5	32.7	15
16	1392.6	32.9	1405.8	33.0	1419.0	33.1	1432.3	33.3	1445.6	33.4	1459.0	33.6	1472.5	33.7	1486.0	33.8	1499.6	34.0	1513.2	34.1	16
17	1526.9	34.3	1540.6	34.4	1554.4	34.5	1568.2	34.7	1582.1	34.8	1596.1	35.0	1610.1	35.1	1624.1	35.2	1638.3	35.4	1652.4	35.5	17
18	1666.7	35.6	1681.0	35.8	1695.3	35.9	1709.7	36.1	1724.1	36.2	1738.7	36.3	1753.2	36.5	1767.8	36.6	1782.5	36.8	1797.2	36.9	18
19	1812.0	37.0	1826.9	37.2	1841.8	37.3	1856.7	37.5	1871.7	37.6	1886.8	37.7	1901.9	37.9	1917.1	38.0	1932.3	38.1	1947.6	38.3	19
20	1963.0	38.4	1978.4	38.6	1993.8	38.7	2009.3	38.8	2024.9	39.0	2040.5	39.1	2056.2	39.3	2071.9	39.4	2087.7	39.5	2103.5	39.7	20
21	2119.4	39.8	2135.4	40.0	2151.4	40.1	2167.5	40.2	2183.6	40.4	2199.8	40.5	2216.0	40.6	2232.3	40.8	2248.6	40.9	2265.0	41.1	21
22	2281.5	41.2	2298.0	41.3	2314.6	41.5	2331.2	41.6	2347.9	41.8	2364.6	41.9	2381.4	42.0	2398.2	42.2	2415.1	42.3	2432.1	42.5	22
23	2449.1	42.6	2466.1	42.7	2483.3	42.9	2500.4	43.0	2517.7	43.1	2535.0	43.3	2552.3	43.4	2569.7	43.6	2587.1	43.7	2604.7	43.8	23
24	2622.2	44.0	2639.8	44.1	2657.5	44.3	2675.2	44.4	2693.0	44.5	2710.9	44.7	2728.8	44.8	2746.7	45.0	2764.7	45.1	2782.8	45.2	24
25	2800.9	45.4	2819.1	45.5	2837.3	45.6	2855.6	45.8	2874.0	45.9	2892.4	46.1	2910.8	46.2	2929.3	46.3	2947.9	46.5	2966.5	46.6	25
26	2985.2	46.8	3003.9	46.9	3022.7	47.0	3041.5	47.2	3060.4	47.3	3079.4	47.5	3098.4	47.6	3117.5	47.7	3136.6	47.9	3155.8	48.0	26
27	3175.0	48.1	3194.3	48.3	3213.6	48.4	3233.0	48.6	3252.5	48.7	3272.0	48.8	3291.6	49.0	3311.2	49.1	3330.9	49.3	3350.6	49.4	27
28	3370.4	49.5	3390.2	49.7	3410.1	49.8	3430.1	50.0	3450.1	50.1	3470.1	50.2	3490.3	50.4	3510.4	50.5	3530.7	50.6	3551.0	50.8	28
29	3571.3	50.9	3591.7	51.1	3612.1	51.2	3632.7	51.3	3653.2	51.5	3673.8	51.6	3694.5	51.8	3715.2	51.9	3736.0	52.0	3756.9	52.2	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 24; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

24

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	11.1	4.5	11.2	9.0	11.4	13.6	11.5	18.2	11.7	22.9	11.8	27.7	11.9	32.5	12.1	37.3	12.2	42.2	12.4	0
1	47.2	12.5	52.2	12.6	57.3	12.8	62.5	12.9	67.7	13.1	72.9	13.2	78.2	13.3	83.6	13.5	89.0	13.6	94.5	13.8	1
2	100.0	13.9	105.6	14.0	111.2	14.2	116.9	14.3	122.7	14.4	128.5	14.6	134.3	14.7	140.2	14.9	146.2	15.0	152.2	15.1	2
3	158.3	15.3	164.5	15.4	170.7	15.6	176.9	15.7	183.2	15.8	189.6	16.0	196.0	16.1	202.5	16.2	209.0	16.4	215.6	16.5	3
4	222.2	16.7	228.9	16.8	235.7	16.9	242.5	17.1	249.3	17.2	256.2	17.4	263.2	17.5	270.2	17.6	277.3	17.8	284.5	17.9	4
5	291.7	18.1	298.9	18.2	306.2	18.3	313.6	18.5	321.0	18.6	328.5	18.8	336.0	18.9	343.6	19.0	351.2	19.2	358.9	19.3	5
6	366.7	19.4	374.5	19.6	382.3	19.7	390.2	19.9	398.2	20.0	406.2	20.1	414.3	20.3	422.5	20.4	430.7	20.6	438.9	20.7	6
7	447.2	20.8	455.6	21.0	464.0	21.1	472.5	21.2	481.0	21.4	489.6	21.5	498.2	21.7	506.9	21.8	515.7	21.9	524.5	22.1	7
8	533.3	22.2	542.2	22.4	551.2	22.5	560.2	22.6	569.3	22.8	578.5	22.9	587.7	23.1	596.9	23.2	606.2	23.3	615.6	23.5	8
9	625.0	23.6	634.5	23.8	644.0	23.9	653.6	24.0	663.2	24.2	672.9	24.3	682.7	24.4	692.5	24.6	702.3	24.7	712.2	24.9	9
10	722.2	25.0	732.2	25.1	742.3	25.3	752.5	25.4	762.7	25.6	772.9	25.7	783.2	25.8	793.6	26.0	804.0	26.1	814.5	26.2	10
11	825.0	26.4	835.6	26.5	846.2	26.7	856.9	26.8	867.7	26.9	878.5	27.1	889.3	27.2	900.2	27.4	911.2	27.5	922.2	27.6	11
12	933.3	27.8	944.5	27.9	955.7	28.1	966.9	28.2	978.2	28.3	989.6	28.5	1001.0	28.6	1012.5	28.8	1024.0	28.9	1035.6	29.0	12
13	1047.2	29.2	1058.9	29.3	1070.7	29.4	1082.5	29.6	1094.3	29.7	1106.2	29.9	1118.2	30.0	1130.2	30.1	1142.3	30.3	1154.5	30.4	13
14	1166.7	30.6	1178.9	30.7	1191.2	30.8	1203.6	31.0	1216.0	31.1	1228.5	31.2	1241.0	31.4	1253.6	31.5	1266.2	31.7	1278.9	31.8	14
15	1291.7	31.9	1304.5	32.1	1317.3	32.2	1330.2	32.4	1343.2	32.5	1356.2	32.6	1369.3	32.8	1382.5	32.9	1395.7	33.1	1408.9	33.2	15
16	1422.2	33.3	1435.6	33.5	1449.0	33.6	1462.5	33.8	1476.0	33.9	1489.6	34.0	1503.2	34.2	1516.9	34.3	1530.7	34.4	1544.5	34.6	16
17	1558.3	34.7	1572.2	34.9	1586.2	35.0	1600.2	35.1	1614.3	35.3	1628.5	35.4	1642.7	35.6	1656.9	35.7	1671.2	35.8	1685.6	36.0	17
18	1700.0	36.1	1714.5	36.2	1729.0	36.4	1743.6	36.5	1758.2	36.7	1772.9	36.8	1787.7	36.9	1802.5	37.1	1817.3	37.2	1832.2	37.4	18
19	1847.2	37.5	1862.2	37.6	1877.3	37.8	1892.5	37.9	1907.7	38.1	1922.9	38.2	1938.2	38.3	1953.6	38.5	1969.0	38.6	1984.5	38.8	19
20	2000.0	38.9	2015.6	39.0	2031.2	39.2	2046.9	39.3	2062.7	39.4	2078.5	39.6	2094.3	39.7	2110.2	39.9	2126.2	40.0	2142.2	40.1	20
21	2158.3	40.3	2174.5	40.4	2190.7	40.6	2206.9	40.7	2223.2	40.8	2239.6	41.0	2256.0	41.1	2272.5	41.2	2289.0	41.4	2305.6	41.5	21
22	2322.2	41.7	2338.9	41.8	2355.7	41.9	2372.5	42.1	2389.3	42.2	2406.2	42.4	2423.2	42.5	2440.2	42.6	2457.3	42.8	2474.5	42.9	22
23	2491.7	43.1	2508.9	43.2	2526.2	43.3	2543.6	43.5	2561.0	43.6	2578.5	43.8	2596.0	43.9	2613.6	44.0	2631.2	44.2	2648.9	44.3	23
24	2666.7	44.4	2684.5	44.6	2702.3	44.7	2720.2	44.9	2738.2	45.0	2756.2	45.1	2774.3	45.3	2792.5	45.4	2810.7	45.6	2828.9	45.7	24
25	2847.2	45.8	2865.6	46.0	2884.0	46.1	2902.5	46.2	2921.0	46.4	2939.6	46.5	2958.2	46.7	2976.9	46.8	2995.7	46.9	3014.5	47.1	25
26	3033.3	47.2	3052.2	47.4	3071.2	47.5	3090.2	47.6	3109.3	47.8	3128.5	47.9	3147.7	48.1	3166.9	48.2	3186.2	48.3	3205.6	48.5	26
27	3225.0	48.6	3244.5	48.8	3264.0	48.9	3283.6	49.0	3303.2	49.2	3322.9	49.3	3342.7	49.4	3362.5	49.6	3382.3	49.7	3402.2	49.9	27
28	3422.2	50.0	3442.2	50.1	3462.3	50.3	3482.5	50.4	3502.7	50.6	3522.9	50.7	3543.2	50.8	3563.6	51.0	3584.0	51.1	3604.5	51.2	28
29	3625.0	51.4	3645.6	51.5	3666.2	51.7	3686.9	51.8	3707.7	51.9	3728.5	52.1	3749.3	52.2	3770.2	52.4	3791.2	52.5	3812.2	52.6	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 25; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	11.6	4.7	11.7	9.4	11.9	14.1	12.0	19.0	12.1	23.8	12.3	28.8	12.4	33.8	12.5	38.8	12.7	43.9	12.8	0
1	49.1	13.0	54.3	13.1	59.6	13.2	64.9	13.4	70.3	13.5	75.7	13.7	81.2	13.8	86.7	13.9	92.3	14.1	98.0	14.2	1
2	103.7	14.4	109.5	14.5	115.3	14.6	121.2	14.8	127.1	14.9	133.1	15.0	139.1	15.2	145.2	15.3	151.4	15.5	157.6	15.6	2
3	163.9	15.7	170.2	15.9	176.6	16.0	183.0	16.2	189.5	16.3	196.1	16.4	202.7	16.6	209.3	16.7	216.0	16.9	222.8	17.0	3
4	229.6	17.1	236.5	17.3	243.4	17.4	250.4	17.5	257.5	17.7	264.6	17.8	271.7	18.0	279.0	18.1	286.2	18.2	293.5	18.4	4
5	300.9	18.5	308.4	18.7	315.9	18.8	323.4	18.9	331.0	19.1	338.7	19.2	346.4	19.4	354.1	19.5	362.0	19.6	369.8	19.8	5
6	377.8	19.9	385.8	20.0	393.8	20.2	401.9	20.3	410.1	20.5	418.3	20.6	426.6	20.7	434.9	20.9	443.3	21.0	451.7	21.2	6
7	460.2	21.3	468.7	21.4	477.3	21.6	486.0	21.7	494.7	21.9	503.5	22.0	512.3	22.1	521.2	22.3	530.1	22.4	539.1	22.5	7
8	548.1	22.7	557.2	22.8	566.4	23.0	575.6	23.1	584.9	23.2	594.2	23.4	603.6	23.5	613.0	23.7	622.5	23.8	632.1	23.9	8
9	641.7	24.1	651.3	24.2	661.0	24.4	670.8	24.5	680.6	24.6	690.5	24.8	700.4	24.9	710.4	25.0	720.5	25.2	730.6	25.3	9
10	740.7	25.5	751.0	25.6	761.2	25.7	771.5	25.9	781.9	26.0	792.4	26.2	802.9	26.3	813.4	26.4	824.0	26.6	834.7	26.7	10
11	845.4	26.9	856.1	27.0	867.0	27.1	877.8	27.3	888.8	27.4	899.8	27.5	910.8	27.7	921.9	27.8	933.1	28.0	944.3	28.1	11
12	955.6	28.2	966.9	28.4	978.3	28.5	989.7	28.7	1001.2	28.8	1012.7	28.9	1024.3	29.1	1036.0	29.2	1047.7	29.4	1059.5	29.5	12
13	1071.3	29.6	1083.2	29.8	1095.1	29.9	1107.1	30.0	1119.1	30.2	1131.2	30.3	1143.4	30.5	1155.6	30.6	1167.9	30.7	1180.2	30.9	13
14	1192.6	31.0	1205.0	31.2	1217.5	31.3	1230.1	31.4	1242.7	31.6	1255.3	31.7	1268.0	31.9	1280.8	32.0	1293.6	32.1	1306.5	32.3	14
15	1319.4	32.4	1332.4	32.5	1345.5	32.7	1358.6	32.8	1371.7	33.0	1385.0	33.1	1398.2	33.2	1411.5	33.4	1424.9	33.5	1438.4	33.7	15
16	1451.9	33.8	1465.4	33.9	1479.0	34.1	1492.7	34.2	1506.4	34.4	1520.1	34.5	1534.0	34.6	1547.8	34.8	1561.8	34.9	1575.8	35.0	16
17	1589.8	35.2	1603.9	35.3	1618.1	35.5	1632.3	35.6	1646.6	35.7	1660.9	35.9	1675.3	36.0	1689.7	36.2	1704.2	36.3	1718.7	36.4	17
18	1733.3	36.6	1748.0	36.7	1762.7	36.9	1777.5	37.0	1792.3	37.1	1807.2	37.3	1822.1	37.4	1837.1	37.5	1852.1	37.7	1867.2	37.8	18
19	1882.4	38.0	1897.6	38.1	1912.9	38.2	1928.2	38.4	1943.6	38.5	1959.0	38.7	1974.5	38.8	1990.1	38.9	2005.7	39.1	2021.3	39.2	19
20	2037.0	39.4	2052.8	39.5	2068.6	39.6	2084.5	39.8	2100.4	39.9	2116.4	40.0	2132.5	40.2	2148.6	40.3	2164.7	40.5	2181.0	40.6	20
21	2197.2	40.7	2213.5	40.9	2229.9	41.0	2246.4	41.2	2262.9	41.3	2279.4	41.4	2296.0	41.6	2312.7	41.7	2329.4	41.9	2346.1	42.0	21
22	2363.0	42.1	2379.8	42.3	2396.8	42.4	2413.8	42.5	2430.8	42.7	2447.9	42.8	2465.1	43.0	2482.3	43.1	2499.6	43.2	2516.9	43.4	22
23	2534.3	43.5	2551.7	43.7	2569.2	43.8	2586.7	43.9	2604.3	44.1	2622.0	44.2	2639.7	44.4	2657.5	44.5	2675.3	44.6	2693.2	44.8	23
24	2711.1	44.9	2729.1	45.0	2747.1	45.2	2765.2	45.3	2783.4	45.5	2801.6	45.6	2819.9	45.7	2838.2	45.9	2856.6	46.0	2875.0	46.2	24
25	2893.5	46.3	2912.1	46.4	2930.7	46.6	2949.3	46.7	2968.0	46.9	2986.8	47.0	3005.6	47.1	3024.5	47.3	3043.4	47.4	3062.4	47.5	25
26	3081.5	47.7	3100.6	47.8	3119.7	48.0	3139.0	48.1	3158.2	48.2	3177.5	48.4	3196.9	48.5	3216.4	48.7	3235.9	48.8	3255.4	48.9	26
27	3275.0	49.1	3294.7	49.2	3314.4	49.4	3334.1	49.5	3354.0	49.6	3373.8	49.8	3393.8	49.9	3413.8	50.0	3433.8	50.2	3453.9	50.3	27
28	3474.1	50.5	3494.3	50.6	3514.6	50.7	3534.9	50.9	3555.3	51.0	3575.7	51.2	3596.2	51.3	3616.7	51.4	3637.3	51.6	3658.0	51.7	28
29	3678.7	51.9	3699.5	52.0	3720.3	52.1	3741.2	52.3	3762.1	52.4	3783.1	52.5	3804.1	52.7	3825.2	52.8	3846.4	53.0	3867.6	53.1	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 26; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

26

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	12.0	4.8	12.2	9.7	12.3	14.7	12.5	19.7	12.6	24.8	12.7	29.9	12.9	35.1	13.0	40.3	13.1	45.6	13.3	0
1	50.9	13.4	56.3	13.6	61.8	13.7	67.3	13.8	72.9	14.0	78.5	14.1	84.1	14.3	89.9	14.4	95.7	14.5	101.5	14.7	1
2	107.4	14.8	113.4	15.0	119.4	15.1	125.4	15.2	131.6	15.4	137.7	15.5	144.0	15.6	150.2	15.8	156.6	15.9	163.0	16.1	2
3	169.4	16.2	176.0	16.3	182.5	16.5	189.1	16.6	195.8	16.8	202.5	16.9	209.3	17.0	216.2	17.2	223.1	17.3	230.0	17.5	3
4	237.0	17.6	244.1	17.7	251.2	17.9	258.4	18.0	265.6	18.1	272.9	18.3	280.3	18.4	287.7	18.6	295.1	18.7	302.6	18.8	4
5	310.2	19.0	317.8	19.1	325.5	19.3	333.2	19.4	341.0	19.5	348.8	19.7	356.7	19.8	364.7	20.0	372.7	20.1	380.8	20.2	5
6	388.9	20.4	397.1	20.5	405.3	20.6	413.6	20.8	421.9	20.9	430.3	21.1	438.8	21.2	447.3	21.3	455.9	21.5	464.5	21.6	6
7	473.1	21.8	481.9	21.9	490.7	22.0	499.5	22.2	508.4	22.3	517.4	22.5	526.4	22.6	535.4	22.7	544.6	22.9	553.7	23.0	7
8	563.0	23.1	572.2	23.3	581.6	23.4	591.0	23.6	600.4	23.7	610.0	23.8	619.5	24.0	629.1	24.1	638.8	24.3	648.5	24.4	8
9	658.3	24.5	668.2	24.7	678.1	24.8	688.0	25.0	698.0	25.1	708.1	25.2	718.2	25.4	728.4	25.5	738.6	25.6	748.9	25.8	9
10	759.3	25.9	769.7	26.1	780.1	26.2	790.6	26.3	801.2	26.5	811.8	26.6	822.5	26.8	833.2	26.9	844.0	27.0	854.8	27.2	10
11	865.7	27.3	876.7	27.5	887.7	27.6	898.8	27.7	909.9	27.9	921.1	28.0	932.3	28.1	943.6	28.3	954.9	28.4	966.3	28.6	11
12	977.8	28.7	989.3	28.8	1000.9	29.0	1012.5	29.1	1024.1	29.3	1035.9	29.4	1047.7	29.5	1059.5	29.7	1071.4	29.8	1083.4	30.0	12
13	1095.4	30.1	1107.4	30.2	1119.6	30.4	1131.7	30.5	1144.0	30.6	1156.2	30.8	1168.6	30.9	1181.0	31.1	1193.4	31.2	1206.0	31.3	13
14	1218.5	31.5	1231.1	31.6	1243.8	31.8	1256.5	31.9	1269.3	32.0	1282.2	32.2	1295.1	32.3	1308.0	32.5	1321.0	32.6	1334.1	32.7	14
15	1347.2	32.9	1360.4	33.0	1373.6	33.1	1386.9	33.3	1400.3	33.4	1413.7	33.6	1427.1	33.7	1440.6	33.8	1454.2	34.0	1467.8	34.1	15
16	1481.5	34.3	1495.2	34.4	1509.0	34.5	1522.8	34.7	1536.7	34.8	1550.7	35.0	1564.7	35.1	1578.8	35.2	1592.9	35.4	1607.1	35.5	16
17	1621.3	35.6	1635.6	35.8	1649.9	35.9	1664.3	36.1	1678.8	36.2	1693.3	36.3	1707.9	36.5	1722.5	36.6	1737.1	36.8	1751.9	36.9	17
18	1766.7	37.0	1781.5	37.2	1796.4	37.3	1811.4	37.5	1826.4	37.6	1841.4	37.7	1856.6	37.9	1871.7	38.0	1887.0	38.1	1902.2	38.3	18
19	1917.6	38.4	1933.0	38.6	1948.4	38.7	1964.0	38.8	1979.5	39.0	1995.1	39.1	2010.8	39.3	2026.5	39.4	2042.3	39.5	2058.2	39.7	19
20	2074.1	39.8	2090.0	40.0	2106.0	40.1	2122.1	40.2	2138.2	40.4	2154.4	40.5	2170.6	40.6	2186.9	40.8	2203.3	40.9	2219.7	41.1	20
21	2236.1	41.2	2252.6	41.3	2269.2	41.5	2285.8	41.6	2302.5	41.8	2319.2	41.9	2336.0	42.0	2352.8	42.2	2369.7	42.3	2386.7	42.5	21
22	2403.7	42.6	2420.8	42.7	2437.9	42.9	2455.1	43.0	2472.3	43.1	2489.6	43.3	2506.9	43.4	2524.3	43.6	2541.8	43.7	2559.3	43.8	22
23	2576.9	44.0	2594.5	44.1	2612.1	44.3	2629.9	44.4	2647.7	44.5	2665.5	44.7	2683.4	44.8	2701.4	45.0	2719.4	45.1	2737.4	45.2	23
24	2755.6	45.4	2773.7	45.5	2792.0	45.6	2810.2	45.8	2828.6	45.9	2847.0	46.1	2865.4	46.2	2884.0	46.3	2902.5	46.5	2921.1	46.6	24
25	2939.8	46.8	2958.5	46.9	2977.3	47.0	2996.2	47.2	3015.1	47.3	3034.0	47.5	3053.0	47.6	3072.1	47.7	3091.2	47.9	3110.4	48.0	25
26	3129.6	48.1	3148.9	48.3	3168.3	48.4	3187.7	48.6	3207.1	48.7	3226.6	48.8	3246.2	49.0	3265.8	49.1	3285.5	49.3	3305.2	49.4	26
27	3325.0	49.5	3344.8	49.7	3364.7	49.8	3384.7	50.0	3404.7	50.1	3424.8	50.2	3444.9	50.4	3465.1	50.5	3485.3	50.6	3505.6	50.8	27
28	3525.9	50.9	3546.3	51.1	3566.8	51.2	3587.3	51.3	3607.9	51.5	3628.5	51.6	3649.1	51.8	3669.9	51.9	3690.7	52.0	3711.5	52.2	28
29	3732.4	52.3	3753.4	52.5	3774.4	52.6	3795.4	52.7	3816.6	52.9	3837.7	53.0	3859.0	53.1	3880.2	53.3	3901.6	53.4	3923.0	53.6	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 27; SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	27																				
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	12.5	5.0	12.6	10.1	12.8	15.2	12.9	20.4	13.1	25.7	13.2	31.0	13.3	36.4	13.5	41.8	13.6	47.2	13.8	0
1	52.8	13.9	58.4	14.0	64.0	14.2	69.7	14.3	75.4	14.4	81.2	14.6	87.1	14.7	93.0	14.9	99.0	15.0	105.0	15.1	1
2	111.1	15.3	117.2	15.4	123.4	15.6	129.7	15.7	136.0	15.8	142.4	16.0	148.8	16.1	155.2	16.2	161.8	16.4	168.4	16.5	2
3	175.0	16.7	181.7	16.8	188.4	16.9	195.2	17.1	202.1	17.2	209.0	17.4	216.0	17.5	223.0	17.6	230.1	17.8	237.2	17.9	3
4	244.4	18.1	251.7	18.2	259.0	18.3	266.4	18.5	273.8	18.6	281.2	18.8	288.8	18.9	296.4	19.0	304.0	19.2	311.7	19.3	4
5	319.4	19.4	327.2	19.6	335.1	19.7	343.0	19.9	351.0	20.0	359.0	20.1	367.1	20.3	375.2	20.4	383.4	20.6	391.7	20.7	5
6	400.0	20.8	408.4	21.0	416.8	21.1	425.2	21.2	433.8	21.4	442.4	21.5	451.0	21.7	459.7	21.8	468.4	21.9	477.2	22.1	6
7	486.1	22.2	495.0	22.4	504.0	22.5	513.0	22.6	522.1	22.8	531.2	22.9	540.4	23.1	549.7	23.2	559.0	23.3	568.4	23.5	7
8	577.8	23.6	587.2	23.8	596.8	23.9	606.4	24.0	616.0	24.2	625.7	24.3	635.4	24.4	645.2	24.6	655.1	24.7	665.0	24.9	8
9	675.0	25.0	685.0	25.1	695.1	25.3	705.2	25.4	715.4	25.6	725.7	25.7	736.0	25.8	746.4	26.0	756.8	26.1	767.2	26.2	9
10	777.8	26.4	788.4	26.5	799.0	26.7	809.7	26.8	820.4	26.9	831.2	27.1	842.1	27.2	853.0	27.4	864.0	27.5	875.0	27.6	10
11	886.1	27.8	897.2	27.9	908.4	28.1	919.7	28.2	931.0	28.3	942.4	28.5	953.8	28.6	965.2	28.8	976.8	28.9	988.4	29.0	11
12	1000.0	29.2	1011.7	29.3	1023.4	29.4	1035.2	29.6	1047.1	29.7	1059.0	29.9	1071.0	30.0	1083.0	30.1	1095.1	30.3	1107.2	30.4	12
13	1119.4	30.6	1131.7	30.7	1144.0	30.8	1156.4	31.0	1168.8	31.1	1181.2	31.2	1193.8	31.4	1206.4	31.5	1219.0	31.7	1231.7	31.8	13
14	1244.4	31.9	1257.2	32.1	1270.1	32.2	1283.0	32.4	1296.0	32.5	1309.0	32.6	1322.1	32.8	1335.2	32.9	1348.4	33.1	1361.7	33.2	14
15	1375.0	33.3	1388.4	33.5	1401.8	33.6	1415.2	33.8	1428.8	33.9	1442.4	34.0	1456.0	34.2	1469.7	34.3	1483.4	34.4	1497.2	34.6	15
16	1511.1	34.7	1525.0	34.9	1539.0	35.0	1553.0	35.1	1567.1	35.3	1581.2	35.4	1595.4	35.6	1609.7	35.7	1624.0	35.8	1638.4	36.0	16
17	1652.8	36.1	1667.2	36.2	1681.8	36.4	1696.4	36.5	1711.0	36.7	1725.7	36.8	1740.4	36.9	1755.2	37.1	1770.1	37.2	1785.0	37.4	17
18	1800.0	37.5	1815.0	37.6	1830.1	37.8	1845.2	37.9	1860.4	38.1	1875.7	38.2	1891.0	38.3	1906.4	38.5	1921.8	38.6	1937.2	38.8	18
19	1952.8	38.9	1968.4	39.0	1984.0	39.2	1999.7	39.3	2015.4	39.4	2031.2	39.6	2047.1	39.7	2063.0	39.9	2079.0	40.0	2095.0	40.1	19
20	2111.1	40.3	2127.2	40.4	2143.4	40.6	2159.7	40.7	2176.0	40.8	2192.4	41.0	2208.8	41.1	2225.2	41.2	2241.8	41.4	2258.4	41.5	20
21	2275.0	41.7	2291.7	41.8	2308.4	41.9	2325.2	42.1	2342.1	42.2	2359.0	42.4	2376.0	42.5	2393.0	42.6	2410.1	42.8	2427.2	42.9	21
22	2444.4	43.1	2461.7	43.2	2479.0	43.3	2496.4	43.5	2513.8	43.6	2531.2	43.8	2548.8	43.9	2566.4	44.0	2584.0	44.2	2601.7	44.3	22
23	2619.4	44.4	2637.2	44.6	2655.1	44.7	2673.0	44.9	2691.0	45.0	2709.0	45.1	2727.1	45.3	2745.2	45.4	2763.4	45.6	2781.7	45.7	23
24	2800.0	45.8	2818.4	46.0	2836.8	46.1	2855.2	46.2	2873.8	46.4	2892.4	46.5	2911.0	46.7	2929.7	46.8	2948.4	46.9	2967.2	47.1	24
25	2986.1	47.2	3005.0	47.4	3024.0	47.5	3043.0	47.6	3062.1	47.8	3081.2	47.9	3100.4	48.1	3119.7	48.2	3139.0	48.3	3158.4	48.5	25
26	3177.8	48.6	3197.2	48.8	3216.8	48.9	3236.4	49.0	3256.0	49.2	3275.7	49.3	3295.4	49.4	3315.2	49.6	3335.1	49.7	3355.0	49.9	26
27	3375.0	50.0	3395.0	50.1	3415.1	50.3	3435.2	50.4	3455.4	50.6	3475.7	50.7	3496.0	50.8	3516.4	51.0	3536.8	51.1	3557.2	51.2	27
28	3577.8	51.4	3598.4	51.5	3619.0	51.7	3639.7	51.8	3660.4	51.9	3681.2	52.1	3702.1	52.2	3723.0	52.4	3744.0	52.5	3765.0	52.6	28
29	3786.1	52.8	3807.2	52.9	3828.4	53.1	3849.7	53.2	3871.0	53.3	3892.4	53.5	3913.8	53.6	3935.2	53.8	3956.8	53.9	3978.4	54.0	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 28: SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

	28																				
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	13.0	5.2	13.1	10.5	13.2	15.8	13.4	21.2	13.5	26.6	13.7	32.1	13.8	37.7	13.9	43.3	14.1	48.9	14.2	0
1	54.6	14.4	60.4	14.5	66.2	14.6	72.1	14.8	78.0	14.9	84.0	15.0	90.1	15.2	96.2	15.3	102.3	15.5	108.5	15.6	1
2	114.8	15.7	121.1	15.9	127.5	16.0	134.0	16.2	140.4	16.3	147.0	16.4	153.6	16.6	160.2	16.7	167.0	16.9	173.7	17.0	2
3	180.6	17.1	187.4	17.3	194.4	17.4	201.4	17.5	208.4	17.7	215.5	17.8	222.7	18.0	229.9	18.1	237.1	18.2	244.5	18.4	3
4	251.9	18.5	259.3	18.7	266.8	18.8	274.3	18.9	281.9	19.1	289.6	19.2	297.3	19.4	305.1	19.5	312.9	19.6	320.8	19.8	4
5	328.7	19.9	336.7	20.0	344.7	20.2	352.8	20.3	361.0	20.5	369.2	20.6	377.5	20.7	385.8	20.9	394.2	21.0	402.6	21.2	5
6	411.1	21.3	419.7	21.4	428.3	21.6	436.9	21.7	445.6	21.9	454.4	22.0	463.2	22.1	472.1	22.3	481.0	22.4	490.0	22.5	6
7	499.1	22.7	508.2	22.8	517.3	23.0	526.5	23.1	535.8	23.2	545.1	23.4	554.5	23.5	564.0	23.7	573.4	23.8	583.0	23.9	7
8	592.6	24.1	602.2	24.2	612.0	24.4	621.7	24.5	631.6	24.6	641.4	24.8	651.4	24.9	661.4	25.0	671.4	25.2	681.5	25.3	8
9	691.7	25.5	701.9	25.6	712.1	25.7	722.5	25.9	732.9	26.0	743.3	26.2	753.8	26.3	764.3	26.4	774.9	26.6	785.6	26.7	9
10	796.3	26.9	807.1	27.0	817.9	27.1	828.8	27.3	839.7	27.4	850.7	27.5	861.7	27.7	872.8	27.8	884.0	28.0	895.2	28.1	10
11	906.5	28.2	917.8	28.4	929.2	28.5	940.6	28.7	952.1	28.8	963.7	28.9	975.3	29.1	986.9	29.2	998.6	29.4	1010.4	29.5	11
12	1022.2	29.6	1034.1	29.8	1046.0	29.9	1058.0	30.0	1070.1	30.2	1082.2	30.3	1094.3	30.5	1106.5	30.6	1118.8	30.7	1131.1	30.9	12
13	1143.5	31.0	1156.0	31.2	1168.4	31.3	1181.0	31.4	1193.6	31.6	1206.2	31.7	1219.0	31.9	1231.7	32.0	1244.6	32.1	1257.4	32.3	13
14	1270.4	32.4	1283.4	32.5	1296.4	32.7	1309.5	32.8	1322.7	33.0	1335.9	33.1	1349.1	33.2	1362.5	33.4	1375.9	33.5	1389.3	33.7	14
15	1402.8	33.8	1416.3	33.9	1429.9	34.1	1443.6	34.2	1457.3	34.4	1471.1	34.5	1484.9	34.6	1498.8	34.8	1512.7	34.9	1526.7	35.0	15
16	1540.7	35.2	1554.8	35.3	1569.0	35.5	1583.2	35.6	1597.5	35.7	1611.8	35.9	1626.2	36.0	1640.6	36.2	1655.1	36.3	1669.7	36.4	16
17	1684.3	36.6	1698.9	36.7	1713.6	36.9	1728.4	37.0	1743.2	37.1	1758.1	37.3	1773.0	37.4	1788.0	37.5	1803.1	37.7	1818.2	37.8	17
18	1833.3	38.0	1848.5	38.1	1863.8	38.2	1879.1	38.4	1894.5	38.5	1910.0	38.7	1925.4	38.8	1941.0	38.9	1956.6	39.1	1972.2	39.2	18
19	1988.0	39.4	2003.7	39.5	2019.6	39.6	2035.4	39.8	2051.4	39.9	2067.4	40.0	2083.4	40.2	2099.5	40.3	2115.7	40.5	2131.9	40.6	19
20	2148.1	40.7	2164.5	40.9	2180.9	41.0	2197.3	41.2	2213.8	41.3	2230.3	41.4	2246.9	41.6	2263.6	41.7	2280.3	41.9	2297.1	42.0	20
21	2313.9	42.1	2330.8	42.3	2347.7	42.4	2364.7	42.5	2381.7	42.7	2398.8	42.8	2416.0	43.0	2433.2	43.1	2450.5	43.2	2467.8	43.4	21
22	2485.2	43.5	2502.6	43.7	2520.1	43.8	2537.7	43.9	2555.3	44.1	2572.9	44.2	2590.6	44.4	2608.4	44.5	2626.2	44.6	2644.1	44.8	22
23	2662.0	44.9	2680.0	45.0	2698.1	45.2	2716.2	45.3	2734.3	45.5	2752.5	45.6	2770.8	45.7	2789.1	45.9	2807.5	46.0	2826.0	46.2	23
24	2844.4	46.3	2863.0	46.4	2881.6	46.6	2900.2	46.7	2919.0	46.9	2937.7	47.0	2956.6	47.1	2975.4	47.3	2994.4	47.4	3013.4	47.5	24
25	3032.4	47.7	3051.5	47.8	3070.7	48.0	3089.9	48.1	3109.1	48.2	3128.5	48.4	3147.9	48.5	3167.3	48.7	3186.8	48.8	3206.3	48.9	25
26	3225.9	49.1	3245.6	49.2	3265.3	49.4	3285.1	49.5	3304.9	49.6	3324.8	49.8	3344.7	49.9	3364.7	50.0	3384.7	50.2	3404.8	50.3	26
27	3425.0	50.5	3445.2	50.6	3465.5	50.7	3485.8	50.9	3506.2	51.0	3526.6	51.2	3547.1	51.3	3567.7	51.4	3588.3	51.6	3608.9	51.7	27
28	3629.6	51.9	3650.4	52.0	3671.2	52.1	3692.1	52.3	3713.0	52.4	3734.0	52.5	3755.1	52.7	3776.2	52.8	3797.3	53.0	3818.5	53.1	28
29	3839.8	53.2	3861.1	53.4	3882.5	53.5	3904.0	53.7	3925.4	53.8	3947.0	53.9	3968.6	54.1	3990.2	54.2	4012.0	54.4	4033.7	54.5	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

TABLE XXXII.—BASE 29: SLOPE 1½ TO 1. CU. YDS. PER 50 FT.

29

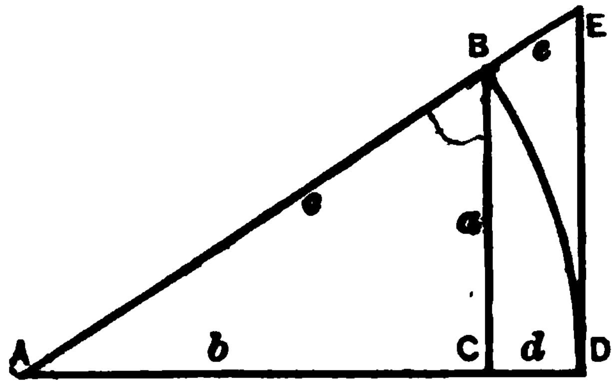
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	13.4	5.4	13.6	10.9	13.7	16.4	13.8	21.9	14.0	27.5	14.1	33.2	14.3	39.0	14.4	44.7	14.5	50.6	14.7	0
1	56.5	14.8	62.4	15.0	68.4	15.1	74.5	15.2	80.6	15.4	86.8	15.5	93.0	15.6	99.3	15.8	105.7	15.9	112.1	16.1	1
2	118.5	16.2	125.0	16.3	131.6	16.5	138.2	16.6	144.9	16.8	151.6	16.9	158.4	17.0	165.2	17.2	172.1	17.3	179.1	17.5	2
3	186.1	17.6	193.2	17.7	200.3	17.9	207.5	18.0	214.7	18.1	222.0	18.3	229.3	18.4	236.7	18.6	244.2	18.7	251.7	18.8	3
4	259.3	19.0	266.9	19.1	274.6	19.3	282.3	19.4	290.1	19.5	297.9	19.7	305.8	19.8	313.8	20.0	321.8	20.1	329.8	20.2	4
5	338.0	20.4	346.1	20.5	354.4	20.6	362.7	20.8	371.0	20.9	379.4	21.1	387.9	21.2	396.4	21.3	404.9	21.5	413.5	21.6	5
6	422.2	21.8	431.0	21.9	439.7	22.0	448.6	22.2	457.5	22.3	466.4	22.5	475.4	22.6	484.5	22.7	493.6	22.9	502.8	23.0	6
7	512.0	23.1	521.3	23.3	530.7	23.4	540.1	23.6	549.5	23.7	559.0	23.8	568.6	24.0	578.2	24.1	587.9	24.3	597.6	24.4	7
8	607.4	24.5	617.2	24.7	627.1	24.8	637.1	25.0	647.1	25.1	657.2	25.2	667.3	25.4	677.5	25.5	687.7	25.6	698.0	25.8	8
9	708.3	25.9	718.7	26.1	729.2	26.2	739.7	26.3	750.3	26.5	760.9	26.6	771.6	26.8	782.3	26.9	793.1	27.0	803.9	27.2	9
10	814.8	27.3	825.8	27.5	836.8	27.6	847.8	27.7	859.0	27.9	870.1	28.0	881.4	28.1	892.7	28.3	904.0	28.4	915.4	28.6	10
11	926.9	28.7	938.4	28.8	949.9	29.0	961.5	29.1	973.2	29.3	985.0	29.4	996.7	29.5	1008.6	29.7	1020.5	29.8	1032.4	30.0	11
12	1044.4	30.1	1056.5	30.2	1068.6	30.4	1080.8	30.5	1093.0	30.6	1105.3	30.8	1117.7	30.9	1130.1	31.1	1142.5	31.2	1155.0	31.3	12
13	1167.6	31.5	1180.2	31.6	1192.9	31.8	1205.6	31.9	1218.4	32.0	1231.2	32.2	1244.1	32.3	1257.1	32.5	1270.1	32.6	1283.2	32.7	13
14	1296.3	32.9	1309.5	33.0	1322.7	33.1	1336.0	33.3	1349.3	33.4	1362.7	33.6	1376.2	33.7	1389.7	33.8	1403.3	34.0	1416.9	34.1	14
15	1430.6	34.3	1444.3	34.4	1458.1	34.5	1471.9	34.7	1485.8	34.8	1499.8	35.0	1513.8	35.1	1527.8	35.2	1542.0	35.4	1556.1	35.5	15
16	1570.4	35.6	1584.7	35.8	1599.0	35.9	1613.4	36.1	1627.9	36.2	1642.4	36.3	1656.9	36.5	1671.5	36.6	1686.2	36.8	1701.0	36.9	16
17	1715.7	37.0	1730.6	37.2	1745.5	37.3	1760.4	37.5	1775.4	37.6	1790.5	37.7	1805.6	37.9	1820.8	38.0	1836.0	38.1	1851.3	38.3	17
18	1866.7	38.4	1882.1	38.6	1897.5	38.7	1913.0	38.8	1928.6	39.0	1944.2	39.1	1959.9	39.3	1975.6	39.4	1991.4	39.5	2007.2	39.7	18
19	2023.1	39.8	2039.1	40.0	2055.1	40.1	2071.2	40.2	2087.3	40.4	2103.5	40.5	2119.7	40.6	2136.0	40.8	2152.3	40.9	2168.7	41.1	19
20	2185.2	41.2	2201.7	41.3	2218.3	41.5	2234.9	41.6	2251.6	41.8	2268.3	41.9	2285.1	42.0	2301.9	42.2	2318.8	42.3	2335.8	42.5	20
21	2352.8	42.6	2369.8	42.7	2387.0	42.9	2404.1	43.0	2421.4	43.1	2438.7	43.3	2456.0	43.4	2473.4	43.6	2490.9	43.7	2508.4	43.8	21
22	2525.9	44.0	2543.5	44.1	2561.2	44.3	2579.0	44.4	2596.7	44.5	2614.6	44.7	2632.5	44.8	2650.4	45.0	2668.4	45.1	2686.5	45.2	22
23	2704.6	45.4	2722.8	45.5	2741.0	45.6	2759.3	45.8	2777.7	45.9	2796.1	46.1	2814.5	46.2	2833.0	46.3	2851.6	46.5	2870.2	46.6	23
24	2888.9	46.8	2907.6	46.9	2926.4	47.0	2945.2	47.2	2964.1	47.3	2983.1	47.5	3002.1	47.6	3021.2	47.7	3040.3	47.9	3059.5	48.0	24
25	3078.7	48.1	3098.0	48.3	3117.3	48.4	3136.7	48.6	3156.2	48.7	3175.7	48.8	3195.3	49.0	3214.9	49.1	3234.6	49.3	3254.3	49.4	25
26	3274.1	49.5	3293.9	49.7	3313.8	49.8	3333.8	50.0	3353.8	50.1	3373.8	50.2	3394.0	50.4	3414.1	50.5	3434.4	50.6	3454.7	50.8	26
27	3475.0	50.9	3495.4	51.1	3515.9	51.2	3536.4	51.3	3556.9	51.5	3577.5	51.6	3598.2	51.8	3619.0	51.9	3639.7	52.0	3660.6	52.2	27
28	3681.5	52.3	3702.4	52.5	3723.4	52.6	3744.5	52.7	3765.6	52.9	3786.8	53.0	3808.0	53.1	3829.3	53.3	3850.7	53.4	3872.1	53.6	28
29	3893.5	53.7	3915.0	53.8	3936.6	54.0	3958.2	54.1	3979.9	54.3	4001.6	54.4	4023.4	54.5	4045.2	54.7	4067.1	54.8	4089.1	55.0	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

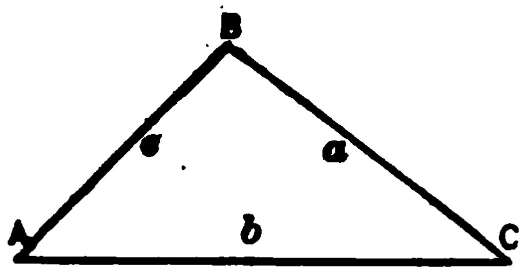
TABLE XXXII.—BASE 30: SLOPE 1¼ TO 1. CU. YDS. PER 50 FT.

30

	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		
c	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	L.	K.	c
0	0.0	13.9	5.6	14.0	11.2	14.2	16.9	14.3	22.7	14.4	28.5	14.6	34.3	14.7	40.2	14.9	46.2	15.0	52.2	15.1	0
1	58.3	15.3	64.5	15.4	70.7	15.6	76.9	15.7	83.2	15.8	89.6	16.0	96.0	16.1	102.5	16.2	109.0	16.4	115.6	16.5	1
2	122.2	16.7	128.9	16.8	135.7	16.9	142.5	17.1	149.3	17.2	156.2	17.4	163.2	17.5	170.2	17.6	177.3	17.8	184.5	17.9	2
3	191.7	18.1	198.9	18.2	206.2	18.3	213.6	18.5	221.0	18.6	228.5	18.8	236.0	18.9	243.6	19.0	251.2	19.2	258.9	19.3	3
4	266.7	19.4	274.5	19.6	282.3	19.7	290.2	19.9	298.2	20.0	306.2	20.1	314.3	20.3	322.5	20.4	330.7	20.6	338.9	20.7	4
5	347.2	20.8	355.6	21.0	364.0	21.1	372.5	21.2	381.0	21.4	389.6	21.5	398.2	21.7	406.9	21.8	415.7	21.9	424.5	22.1	5
6	433.3	22.2	442.2	22.4	451.2	22.5	460.2	22.6	469.3	22.8	478.5	22.9	487.7	23.1	496.9	23.2	506.2	23.3	515.6	23.5	6
7	525.0	23.6	534.5	23.8	544.0	23.9	553.6	24.0	563.2	24.2	572.9	24.3	582.7	24.4	592.5	24.6	602.3	24.7	612.2	24.9	7
8	622.2	25.0	632.2	25.1	642.3	25.3	652.5	25.4	662.7	25.6	672.9	25.7	683.2	25.8	693.6	26.0	704.0	26.1	714.5	26.2	8
9	725.0	26.4	735.6	26.5	746.2	26.7	756.9	26.8	767.7	26.9	778.5	27.1	789.3	27.2	800.2	27.4	811.2	27.5	822.2	27.6	9
10	833.3	27.8	844.5	27.9	855.7	28.1	866.9	28.2	878.2	28.3	889.6	28.5	901.0	28.6	912.5	28.8	924.0	28.9	935.6	29.0	10
11	947.2	29.2	958.9	29.3	970.7	29.4	982.5	29.6	994.3	29.7	1006.2	29.9	1018.2	30.0	1030.2	30.1	1042.3	30.3	1054.5	30.4	11
12	1066.7	30.6	1078.9	30.7	1091.2	30.8	1103.6	31.0	1116.0	31.1	1128.5	31.2	1141.0	31.4	1153.6	31.5	1166.2	31.7	1178.9	31.8	12
13	1191.7	31.9	1204.5	32.1	1217.3	32.2	1230.2	32.4	1243.2	32.5	1256.2	32.6	1269.3	32.8	1282.5	32.9	1295.7	33.1	1308.9	33.2	13
14	1322.2	33.3	1335.6	33.5	1349.0	33.6	1362.5	33.8	1376.0	33.9	1389.6	34.0	1403.2	34.2	1416.9	34.3	1430.7	34.4	1444.5	34.6	14
15	1458.3	34.7	1472.2	34.9	1486.2	35.0	1500.2	35.1	1514.3	35.3	1528.5	35.4	1542.7	35.6	1556.9	35.7	1571.2	35.8	1585.6	36.0	15
16	1600.0	36.1	1614.5	36.2	1629.0	36.4	1643.6	36.5	1658.2	36.7	1672.9	36.8	1687.7	36.9	1702.5	37.1	1717.3	37.2	1732.2	37.4	16
17	1747.2	37.5	1762.2	37.6	1777.3	37.8	1792.5	37.9	1807.7	38.1	1822.9	38.2	1838.2	38.3	1853.6	38.5	1869.0	38.6	1884.5	38.8	17
18	1900.0	38.9	1915.6	39.0	1931.2	39.2	1946.9	39.3	1962.7	39.4	1978.5	39.6	1994.3	39.7	2010.2	39.9	2026.2	40.0	2042.2	40.1	18
19	2058.3	40.3	2074.5	40.4	2090.7	40.6	2106.9	40.7	2123.2	40.8	2139.6	41.0	2156.0	41.1	2172.5	41.2	2189.0	41.4	2205.6	41.5	19
20	2222.2	41.7	2238.9	41.8	2255.7	41.9	2272.5	42.1	2289.3	42.2	2306.2	42.4	2323.2	42.5	2340.2	42.6	2357.3	42.8	2374.5	42.9	20
21	2391.7	43.1	2408.9	43.2	2426.2	43.3	2443.6	43.5	2461.0	43.6	2478.5	43.8	2496.0	43.9	2513.6	44.0	2531.2	44.2	2548.9	44.3	21
22	2566.7	44.4	2584.5	44.6	2602.3	44.7	2620.2	44.9	2638.2	45.0	2656.2	45.1	2674.3	45.3	2692.5	45.4	2710.7	45.6	2728.9	45.7	22
23	2747.2	45.8	2765.6	46.0	2784.0	46.1	2802.5	46.2	2821.0	46.4	2839.6	46.5	2858.2	46.7	2876.9	46.8	2895.7	46.9	2914.5	47.1	23
24	2933.3	47.2	2952.2	47.4	2971.2	47.5	2990.2	47.6	3009.3	47.8	3028.5	47.9	3047.7	48.1	3066.9	48.2	3086.2	48.3	3105.6	48.5	24
25	3125.0	48.6	3144.5	48.8	3164.0	48.9	3183.6	49.0	3203.2	49.2	3222.9	49.3	3242.7	49.4	3262.5	49.6	3282.3	49.7	3302.2	49.9	25
26	3322.2	50.0	3342.2	50.1	3362.3	50.3	3382.5	50.4	3402.7	50.6	3422.9	50.7	3443.2	50.8	3463.6	51.0	3484.0	51.1	3504.5	51.2	26
27	3525.0	51.4	3545.6	51.5	3566.2	51.7	3586.9	51.8	3607.7	51.9	3628.5	52.1	3649.3	52.2	3670.2	52.4	3691.2	52.5	3712.2	52.6	27
28	3733.3	52.8	3754.5	52.9	3775.7	53.1	3796.9	53.2	3818.2	53.3	3839.6	53.5	3861.0	53.6	3882.5	53.8	3904.0	53.9	3925.6	54.0	28
29	3947.2	54.2	3968.9	54.3	3990.7	54.4	4012.5	54.6	4034.3	54.7	4056.2	54.9	4078.2	55.0	4100.2	55.1	4122.3	55.3	4144.5	55.4	29
	.0		.1		.2		.3		.4		.5		.6		.7		.8		.9		

	Symbol.	Number.	Logarithm.
Ratio of circumference to diameter Area of circle (πr^2) radius = 1 Surface of sphere (πd^2) diam. = 1	π	3.14159	0.497150
Reciprocal of same	$\frac{1}{\pi}$	0.31831	9.502850
Area of circle $\left(\frac{\pi d^2}{4}\right)$ diameter = 1 . .	$\frac{1}{4}\pi$	0.78540	9.895090
Volume of sphere ($\frac{4}{3}\pi r^3$) radius = 1 .	$\frac{4}{3}\pi$	4.18879	0.622089
Area of sector of circle (length of arc = l)	$\frac{1}{2}lr.$		
Area of segment of parabola (c = chord; m = mid. ord.)	$\frac{2}{3}cm.$		
Area of segment of circle (ap.)	$\frac{2}{3}cm.$		
Base of hyperbolic logarithms	ϵ	2.71828	0.434294
Modulus of common system of logs. = log ϵ	M	0.43429	9.637784
Reciprocal of same = hyp. log. 10 . . .	$\frac{1}{M}$	2.30259	0.362216
Length of seconds pendulum at N. Y. (inches)		39.1017	1.592196
Acceleration due to gravity at New York	g	32.15949	1.507309
Cubic inches in 1 U. S. gallon		231	2.363612
Cubic inches in 1 Imperial gallon . . .		277.274	2.442909
U. S. gallons in 1 cubic foot		7.4805	0.873931
Imperial gallons in 1 cubic foot . . .		6.2321	0.794634
Feet in 1 meter		3.280833	0.515984
Inches in 1 meter		39.37	1.595165
Miles in 1 kilometer		0.62137	9.793350
Square feet in 1 square meter		10.7639	1.031968
Cubic feet in 1 cubic meter		35.3145	1.547953
Pounds (Av.) in 1 kilogram		2.20462	0.343334
Ton (2240 lbs.) in 1 tonne		0.98421	9.993086
Ft.-lbs. in 1 kilogram-meter		7.23300	0.859318
Feet in 1 mile		5280	3.722634
Square feet in 1 acre		43560	4.639088





SOLUTION OF RIGHT TRIANGLES.

1. $\sin A=\frac{a}{c}=\cos B$
2. $\cos A=\frac{b}{c}=\sin B$
3. $\tan A=\frac{a}{b}=\cot B$
4. $\cot A=\frac{b}{a}=\tan B$
5. $\sec A=\frac{c}{b}=\operatorname{cosec} B$
6. $\operatorname{cosec} A=\frac{c}{a}=\sec B$
7. $\operatorname{vers} A=\frac{c-b}{c}=\frac{d}{c}$
8. $\operatorname{exsec} A=\frac{e}{c}$
9. $a=c\sin A=b\tan A=c\cos B=b\cot B=\sqrt{(c+b)(c-b)}$
10. $b=c\cos A=a\cot A=c\sin B=a\tan B=\sqrt{(c+a)(c-a)}$
11. $d=c\operatorname{vers} A$
12. $e=c\operatorname{exsec} A$
13. $c=\frac{a}{\cos B}=\frac{b}{\sin B}=\frac{a}{\sin A}=\frac{b}{\cos A}=\frac{d}{\operatorname{vers} A}=\frac{e}{\operatorname{exsec} A}$

SOLUTION OF OBLIQUE TRIANGLES.

Given.	Sought.	Formulas.
14. A, B, a	b, c	$b=\frac{a}{\sin A}\cdot\sin B,\quad c=\frac{a}{\sin A}\sin(A+B)$
15. A, a, b	B, c	$\sin B=\frac{\sin A}{a}\cdot b,\quad c=\frac{a}{\sin A}\cdot\sin C.$
16. C, a, b	$A-B$	$\tan\frac{1}{2}(A-B)=\frac{a-b}{a+b}\tan\frac{1}{2}(A+B)$
17. a, b, c	A	Let $s=\frac{1}{2}(a+b+c)$; $\sin\frac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{bc}}$
18.		$\cos\frac{1}{2}A=\sqrt{\frac{s(s-a)}{bc}}$; $\tan\frac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
19.		$\sin A=\frac{2\sqrt{s(s-a)(s-b)(s-c)}}{bc}$;
20.		$\operatorname{vers} A=\frac{2(s-b)(s-c)}{bc}$
21.	area	$\text{area}=\sqrt{s(s-a)(s-b)(s-c)}$
22. A, B, C, a	area	$\text{area}=\frac{a^2\sin B\,.\sin C}{2\sin A}$
23. C, a, b	area	$\text{area}=\frac{1}{2}ab\sin C.$

GENERAL FORMULAS.

24. $\sin A = 2 \sin \frac{1}{2} A \cos \frac{1}{2} A = \sqrt{1 - \cos^2 A} = \tan A \cos A$

25. $\cos A = 2 \cos^2 \frac{1}{2} A - 1 = 1 - 2 \sin^2 \frac{1}{2} A = \cos^2 \frac{1}{2} A - \sin^2 \frac{1}{2} A$

26. $\tan A = \dfrac{\sin A}{\cos A} = \dfrac{\sin 2A}{1 + \cos 2A}$

27. $\cot A = \dfrac{\cos A}{\sin A} = \dfrac{\sin 2A}{1 - \cos 2A} = \dfrac{\sin 2A}{\operatorname{vers} 2A}$

28. $\operatorname{vers} A = 1 - \cos A = \sin A \tan \frac{1}{2} A = 2 \sin^2 \frac{1}{2} A$

29. $\operatorname{exsec} A = \sec A - 1 = \tan A \tan \frac{1}{2} A = \dfrac{\operatorname{vers} A}{\cos A}$

30. $\sin 2A = 2 \sin A \cos A$

31. $\cos 2A = 2 \cos^2 A - 1 = \cos^2 A - \sin^2 A = 1 - 2 \sin^2 A$

32. $\tan 2A = \dfrac{2 \tan A}{1 - \tan^2 A}$

33. $\cot 2A = \dfrac{\cot^2 A - 1}{2 \cot A}$

34. $\operatorname{vers} 2A = 2 \sin^2 A = 2 \sin A \cos A \tan A$

35. $\operatorname{exsec} 2A = \dfrac{2 \tan^2 A}{1 - \tan^2 A}$

36. $\sin^2 A + \cos^2 A = 1$

37. $\sin (A \pm B) = \sin A \cdot \cos B \pm \sin B \cdot \cos A$

38. $\cos (A \pm B) = \cos A \cdot \cos B \mp \sin A \cdot \sin B$

39. $\sin A + \sin B = 2 \sin \frac{1}{2} (A + B) \cos \frac{1}{2} (A - B)$

40. $\sin A - \sin B = 2 \cos \frac{1}{2} (A + B) \sin \frac{1}{2} (A - B)$

41. $\cos A + \cos B = 2 \cos \frac{1}{2} (A + B) \cos \frac{1}{2} (A - B)$

42. $\cos B - \cos A = 2 \sin \frac{1}{2} (A + B) \sin \frac{1}{2} (A - B)$

43. $\sin^2 A - \sin^2 B = \cos^2 B - \cos^2 A = \sin (A + B) \sin (A - B)$

44. $\cos^2 A - \sin^2 B = \cos (A + B) \cos (A - B)$

45. $\tan A + \tan B = \dfrac{\sin (A + B)}{\cos A \cdot \cos B}$

46. $\tan A - \tan B = \dfrac{\sin (A - B)}{\cos A \cdot \cos B}$

SIMPLE CURVE FORMULAS.

(1) $\sin \tfrac{1}{2} D = \dfrac{50}{R}$

(2) $R = \dfrac{50}{\sin \tfrac{1}{2} D}$

(4) $R_a = \dfrac{5730}{D_a}$ (ap.)

(5) $T = R \tan \tfrac{1}{2} I$

(6) $T_a = \dfrac{T_1}{D_a}$ (ap.)

(7) $E = R \operatorname{exsec} \tfrac{1}{2} I$

(8) $E_a = \dfrac{E_1}{D_a}$ (ap.)

(9) $M = R \operatorname{vers} \tfrac{1}{2} I$

(10) $C = 2 R \sin \tfrac{1}{2} I$

(11) $R = T \cot \tfrac{1}{2} I$

(12) $R = \dfrac{E}{\operatorname{exsec} \tfrac{1}{2} I}$

(13) $R = \dfrac{M}{\operatorname{vers} \tfrac{1}{2} I}$

(14) $R = \dfrac{C}{2 \sin \tfrac{1}{2} I}$

(15) $D_a = \dfrac{5730}{R_a}$ (ap.)

(16) $D_a = \dfrac{T_1}{T_a}$ (ap.)

(17) $D_a = \dfrac{E_1}{E_a}$ (ap.)

(18) $c = 2 R \sin \tfrac{1}{2} d$

(19) $\dfrac{c}{100} = \dfrac{d}{D}$ (ap.)

(20) $d = \dfrac{cD}{100}$

(22) $\dfrac{d}{2} = c \times 0.3' \times D_a$ (min.)

(23) $L = 100 \dfrac{I}{D}$ (ap.)

(24) $I = \dfrac{LD}{100}$ (ap.)

(25) $D = \dfrac{100\, I}{L}$

(26) $a = \dfrac{c^2}{2 R} \qquad a_{100} = \dfrac{100^2}{2 R}$

(27) $a_{s-l} = a_1 (D_s - D_l)$

(28) $a_n = n^2 a_{100}$ (ap.)

(29) $a_t = a_{100} \dfrac{c_t^2}{100^2}$

(30) $c - a = \dfrac{h^2}{2 c}$ (ap.) $= \dfrac{h^2}{2 a}$ (ap.)

(31) $M = R - \sqrt{R^2 - \left(\dfrac{c}{2}\right)^2}$

(32) $M = R - \sqrt{\left(R - \dfrac{c}{2}\right)\left(R + \dfrac{c}{2}\right)}$

(33) $\text{Ordinate} = \sqrt{(R + q)(R - q)} - \sqrt{\left(R + \dfrac{c}{2}\right)\left(R - \dfrac{c}{2}\right)}$

(34) $M = \dfrac{c^2}{8 R}$ (ap.)

(35) $\text{Offset} = \dfrac{q^2}{\left(\dfrac{c}{2}\right)^2} M$ (ap.)

(36) $\text{Ordinate} = \dfrac{AQ \times QB}{2 R}$ (ap.)

(37) $AA' = \dfrac{p}{\sin I}$

(38) $R - R' = \dfrac{p}{\operatorname{vers} I}$

(39) $BB' = \dfrac{p}{\sin \tfrac{1}{2} I}$

(40) $R - R' = \dfrac{p}{\operatorname{vers} I}$

(41) $R - R' = \dfrac{p}{\operatorname{exsec} I}$

(42) $AA' = (R - R') \tan I$

COMPOUND AND REVERSED CURVES.

(46) $\operatorname{vers} I_l = \dfrac{T_s \sin I - R_s \operatorname{vers} I}{R_l - R_s}$

(47) $T_l = (R_l - R_s) \sin I_l + R_s \sin I - T_s \cos I.$ Also (49).

(48) $R_l - R_s = \dfrac{T_s \sin I - R_s \operatorname{vers} I}{\operatorname{vers} I_l}$

(50) $\tan \tfrac{1}{2} I_l = \dfrac{T_s \sin I - R_s \operatorname{vers} I}{T_l + T_s \cos I - R_s \sin I}$

(51) $R_l - R_s = \dfrac{T_l + T_s \cos I - R_s \sin I}{\sin I_l}$

(52) $\operatorname{vers} I_s = \dfrac{R_l \operatorname{vers} I - T_l \sin I}{R_l - R_s}$

(53) $T_s = R_l \sin I - (R_l - R_s) \sin I_s - T_l \cos I.$ Also (55).

(54) $R_l - R_s = \dfrac{R_l \operatorname{vers} I - T_l \sin I}{\operatorname{vers} I_s}$

(56) $\tan \tfrac{1}{2} I_s = \dfrac{R_l \operatorname{vers} I - T_l \sin I}{R_l \sin I - T_l \cos I - T_s}$

(57) $R_l - R_s = \dfrac{R_l \sin I - T_l \cos I - T_s}{\sin I_s}$

(64) $\dfrac{p}{R_l - R_s} = \operatorname{vers} I_2$

(65) $\dfrac{p}{R_l - R_s} = \operatorname{vers} I_l' - \operatorname{vers} I_l$

(66) $\dfrac{p}{R_l - R_s} = \operatorname{vers} I_l - \operatorname{vers} I_l'$

(67) $\dfrac{p}{R_l - R_s} = \operatorname{vers} I_s - \operatorname{vers} I_s'$

(68) $\dfrac{p}{R_l - R_s} = \operatorname{vers} I_s' - \operatorname{vers} I_s$

(69) $\operatorname{vers} I_r = \dfrac{\tfrac{1}{2} p}{R}$

(70) $R = \dfrac{\tfrac{1}{2} p}{\operatorname{vers} I_r}$

(72) $R = \dfrac{d^2}{4 p}$

(74) $d = 2\sqrt{Rp}.$

(75) $R_1 + R_2 = \dfrac{p}{\operatorname{vers} I_r}$

(76) $\operatorname{vers} I_r = \dfrac{p}{R_1 + R_2}$

(81) $R = \dfrac{l}{\tan \tfrac{1}{2} I_A + \tan \tfrac{1}{2} I_B}$

(77) $\operatorname{vers} I_2 = \dfrac{R_1 \operatorname{vers} I + T_1 \sin I}{R_1 + R_2}$

(78) $T_2 = T_1 \cos I + R_1 \sin I - (R_1 + R_2) \sin I_2$

(79) $\operatorname{vers} I_1 = \dfrac{R_2 \operatorname{vers} I + T_2 \sin I}{R_1 + R_2}$

(80) $T_1 = T_2 \cos I + R_2 \sin I + (R_1 + R_2) \sin I_1$

PARABOLAS, TURNOUTS, AND SPIRALS.

(82) $y^2 = 4p'x$

(86) $a_1 = \dfrac{g - g'}{2n}$

(87) $n = \dfrac{g - g'}{p}$

(89) $\cot \frac{1}{2} F = 2n$

(91) $R + \dfrac{g}{2} = \dfrac{g - t - k \sin F}{2 \sin \frac{1}{2}(F + S) \sin \frac{1}{2}(F - S)}$

(93) $E_a = l + \dfrac{g - t - k \sin F}{\tan \frac{1}{2}(F + S)} + k \cos F + bn$

(105) $a = g - \left(R + \dfrac{g}{2}\right) \operatorname{vers} F$

(106) $y_a = \left(R + \dfrac{g}{2}\right) \sin F - h \cos F + nb$

(107) $a = g - \left(R + \dfrac{g}{2}\right) \operatorname{vers} F + h \sin F$

(110) $l = \dfrac{p - g - g \cos F}{\sin F}$

(111) $R_2 + \dfrac{g}{2} = \dfrac{p - g}{\operatorname{vers} F}$

(113) $R_2 + \dfrac{g}{2} = \dfrac{p - g - l \sin F}{\operatorname{vers} F}$

(117) $E = 2gn$

(118) $R = 2gn^2$

(120) $\tan \frac{1}{2} O = \dfrac{(p - g)n}{R_m + \dfrac{p}{2}}$

(121) $R_2' - \dfrac{p}{2} = \dfrac{(p - g)n}{\tan \frac{1}{2}(F + O)}$

(132) $\cos I_t = \dfrac{R_1 + a_1 - R_2 - a_2}{R_1 + R_2 + a_3}$

(140) $e = \dfrac{gv^2}{32 \cdot 2\, R}$

(141) $R = \dfrac{R_c l_c}{l}$

(141 A) $\dfrac{D}{D_c} = \dfrac{l}{l_c}$

(142) $s = \dfrac{l^2}{2 R_c l_c}$

(143) $x = \dfrac{y^3}{6 R_c l_c}$

(144) $x = \dfrac{l^3}{6 R_c l_c}$

(145 A) $s_c = \dfrac{l_c D_c}{200}$

(146) $i = \dfrac{s}{3}$; $i_c = \dfrac{s_c}{3}$

(146 A) $i = i_c \left(\dfrac{l}{l_c}\right)^2$

(148) $q = y_c - R_c \sin s_c$

(148 A) $p = x_c - R_c \operatorname{vers} s_c$

(149) $T_s = q + T_c + p \tan \frac{1}{2} I$

(150) $h = \dfrac{p}{\cos \frac{1}{2} I}$

(150 A) $d = q + p \tan \frac{1}{2} I$

(151) $R_1 - R_2 + h = \dfrac{h + p}{\operatorname{vers} \frac{1}{2} I}$

(151 A) $d = q - (R_1 - R_2 + h) \sin \frac{1}{2} I$

(152) $R_1 - R_2 = \dfrac{p}{\operatorname{vers}(\frac{1}{2} I - I_1)}$

(152 A) $d = q - (R_1 - R_2) \sin(\frac{1}{2} I - I_1)$

EARTHWORK.

(153) $r_g = h_i - h_g$

(154) $r_{g_1} = r_{g_0} - g$

(155) $c = r_g - r_c$

(156) $d = \frac{1}{2}b + sc$

(157) $d_r = \frac{1}{2}b + sh_r$

(158) $V = \frac{A_0 + A_1}{2} \cdot l$

(160) $a = c(b + sc)$

(161) $A = \dfrac{c(d_l + d_r) + \frac{b}{2}(h_l + h_r)}{2}$

(162) $A = \left(c + \frac{b}{2s}\right)\frac{D}{2} - \frac{b^2}{4s}$

(163) $A = \dfrac{cb + f_r d_r + f_l d_l}{2}$

(163 A) $V = (A_0 + 4M + A_1)\frac{l}{6}$

(166) $C = \frac{l}{12}(b_1 - b_0)(h_1 - h_0)$

(167) $C = \frac{l}{12}(c_1 - c_0)(D_1 - D_0)$ (ft.)

(168) $C_{100} = \frac{1}{3.24}(c_1 - c_0)(D_1 - D_0)$ (yds.)

(169) $V_p = V_e - C$

(169 A) $V_{p_l} = \frac{l}{100}(V_{e_{100}} - C_{100})$

(173) $C = \left(\frac{b}{2} + sc\right)(h_r - h_l)(d_r + d_l) \times 0.00011\,D$ (yds.)

(174) $C = \left(\frac{b}{2} + sc\right)(h_r - h_l)(d_r + d_l)\frac{l_0 + l_1}{200} \times 0.00011\,D$ (yds.)

(176) $s_1 = \frac{f_l}{15}\left(d_l + p_l - \frac{b}{2}\right)^2$

(178) $s_3 = \dfrac{(f_l p_l + f_r p_r)b}{4}$

(179) $V = A\dfrac{h_1 + h_2 + h_3}{3}$

(180) $V = A\dfrac{h_1 + h_2 + h_3 + h_4}{4}$

(183) $V_t = A\dfrac{t_1 + 2t_2 + 3t_3 + 4t_4}{4}$

(186 A) $S = L + K(h_l + h_r - 2c)$

(185) $V = A\dfrac{h_1 + h_2 + h_3 + h_4}{4} + \dfrac{A}{3}\left(h_c - \dfrac{h_1 + h_2 + h_3 + h_4}{4}\right)$

(185 A) $V = A\dfrac{h_1 + h_2 + h_3 + h_4}{4} + \dfrac{A}{3}\left(h_m - \dfrac{h_1 + h_2}{2}\right)$

(187) $V_{e_{100}} = S_0 + S_1$

(188) $V_{e_l} = (S_0 + S_1)\frac{l}{100}$

(190) $V_{p_l} = (S_0 + S_1 - C)\frac{l}{100}$

(191) $S = \frac{50}{54}aB$

(204) $x_g = \frac{l^2}{12} \cdot \frac{A_1 - A_0}{V}$ (ft.)

(206) $x_{g_{100}} = \frac{100}{6} \cdot \frac{S_1 - S_0}{V}$

(207) $x_{g_l} = x_{g_{100}} \cdot \frac{l}{100}$

(208) $H - H_a = \frac{100}{6}(S_o - S_n)$

EXPLANATION OF TABLES.

For all Circular Curves except Metric Curves the degree D is the central angle subtended by a chord of 100 feet.

Table I. The Radius is computed from the Logarithm, and the latter is in general, therefore, superior in precision. A few of the large Radii at the beginning of this table are taken from ten-place tables and are superior in precision to the corresponding Logarithms. For many computations the Logarithms are more convenient than the Radii themselves.

Table II. Tangent Offsets and Middle Ordinates.
These are given for chords of 100 feet.

Table III. Tangent Distances for a 1° Curve.
Table IV. Correction for Tangent Distances.

The intersection angle I is marked by degrees at the top and minutes at the side. The tangent distance for a curve of any specified degree is obtained by taking from Table III. the tabular number for the given intersection angle, and dividing this by the specified degree of curve. This gives a result approximately correct. The correct result may be obtained by applying from Table IV. the correction for the specified degree of curve and the given intersection angle. This correction is to be added *after dividing* by the degree of curve.

Example. Degree = 9°. Intersection angle = 60° 48′.

Tabular number =	3361.6(9	= D.
	373.51	approx. value T.
	.38	= correction 9° and 61°.
	373.9	= correct value for Tangent Distance.

Table V. External Distances for a 1° Curve.

For any specified degree, divide the tabular number by the specified degree of curve. The result is closely approximate. No table of corrections is given for this. Where definite precision is required, find result by logarithmic computation.

TABLE VI. Spirals for Various Degrees of Curve.

The spiral adopted here is the Am. Ry. Eng. Ass'n spiral in which the length of spiral is the sum of ten equal chords, and in which the spiral angles vary as the squares of the lengths from the *T.S.* The Am. Ry. Eng. Ass'n has computed values of y_c, x_c, C, in terms of the length of spiral l_c. These values have been used as the fundamental basis in computing the values of y_c, x_c, q, p, and the long chord C in this table. Lengths of spiral are here given in multiples of 20 feet for various degrees of curve from 1° to 20°. The values of s_c are also given in this table. For finding the deflection angles this value of s_c is used in Table VII immediately following.

TABLE VII. Deflection Angles for Spirals.

For the values of s_c found in Table VI or by other method, the ten deflection angles to chord points are given. However the spiral may have been selected, when s_c is determined, the values of the ten deflection angles are as found in this table.

TABLE VII A. Deflection Angles from Intermediate Points on Spirals.

For any given spiral when s_c is determined the first deflection angle i_1 is found in Table VII. When the transit is at any intermediate point Table VII A gives coefficients by which i_1 is to be multiplied when sighting at any chord point (forward or backward) used either as a backsight on an established point, or as a new point to be fixed on the spiral.

Example. Spiral angle $s_c = 8°36' = 8.6°$.

Table VII gives $i_1 = 0°01.72'$.

Transit at point 6

$$
\begin{aligned}
&\text{Back deflection to } T.S. && = 01.72' \times 72 = 124' \\
& && = 2°04' \\
&\text{Forward deflection to point } 7 && = 01.72' \times 19 = 0°33' \\
& 8 && = 01.72' \times 40 = 1°09' \\
& 9 && = 01.72' \times 63 = 1°48' \\
& S.C.\ 10 && = 01.72' \times 88 = 2°31'
\end{aligned}
$$

There is a slight approximation in these coefficients but they are correct in ordinary cases and according to the Am. Ry. Eng. Ass'n in any case "if the central angle from the transit point to the point of sight, less the included angle from the *T.S.* to the transit point does not exceed 15°."

TABLE VII B. Spirals. Coefficients of x_c, y_c, p, q.

Ordinarily the spiral will be selected from Table VI and values of p and q taken from that table. In revising line irregular values of l_c and D_c will frequently be used. Table VII B allows values of p and q to be computed with little difficulty and x_c and y_c found if needed. The value of s_c can be found by ordinary computation.

TABLE VII C. Diagram for Length of Spirals.

This diagram explains itself.

TABLE VIII. Long Chords and Actual Arcs.

The actual arc for any given number of full stations may be found by multiplying the length of arc for one station by the number of stations. Actual arcs corresponding to sub-chords may be found by finding the angle and then multiplying the radius by the value taken from Table XX.

TABLE IX. Acres for Strip 100 Feet Wide.

The fractions of acres are carried to hundredths. The "Lengths in Feet" are the limits between which the acres (or fraction of acre) apply.

Example. How many acres in 1146.97 lineal feet? 1146.97 lies between 1143.45 and 1147.81, between which we find 2.63, the required number of acres.

TABLE X. Curves for Metric System.

This is computed on the basis that the Degree of Curve equals the Deflection Angle for a chord of 20 meters, or very nearly that the Degree of Curve is the central angle subtended by a chord of 10 meters or 1 station in length. The radius, the chord, length, offset, or other linear dimensions on the metric curve will be $\frac{2}{10}$ that of U.S. curves of double the degree or nearly $\frac{1}{10}$ those of U.S. curves of the same degree. The table shows the corresponding U.S. degree for each metric curve given.

TABLE XI. Barometric Tables.

The approximate difference in heights in feet is found by taking the difference between the tabular numbers correspond-

ing to the observed readings of the barometer in inches. Temperature correction is made by the formula $\frac{T+t-100}{1000}$ which is easily computed when necessary. The corrected difference in heights $D=(H-h)\left(1+\frac{T+t-100}{1000}\right)$ where H and T represent barometer and thermometer readings at one station and h, t, at the other.

Examples. Barometer Readings 29.83 28.17
Thermometer 75° 62°

Tabular number 28.17 2609
29.83 1049
1560

$$\begin{array}{ll} \text{Temp. corr.} = \frac{75+62-100}{1000} & \begin{array}{r} 1.037 \\ 1560 \\ \hline 6222 \\ 5185 \\ 1037 \\ \hline 1617.720 \end{array} \\ = \frac{37}{1000} & \end{array}$$

Diff. in height = 1618 ft.

TABLE XII. Logarithms of Numbers.

Where there are more than four significant figures, the table of proportional parts will be found useful. The star opposite certain logarithms shows that the two figures at the left are to be taken from the line below.

Example. Required log of 6723.46.

For left 672 and top 3 the logarithm = .827563 and diff. = 65.

Table of prop. parts 65 gives 26 for 4
4 for .6
3.827593

the characteristic 3 being one less than the number of significant figures to the left of the decimal point, in 6723.46.

Example. To find number for log 2.672962
Log of 4709 = .672929
33
Diff. = 92; for 3 prop. part = 28
5.
.5 prop. part = 4.6
Number is 470.935

TABLE XIII. Logarithmic Sines, Cosines, Tangents, and Cotangents.

In taking out degrees and minutes, use the minutes at the left with the degrees at the left, whether the degrees appear at top or at bottom of page ; use the minutes at right in a similar way with the degrees at right. Use headings for Sin., Cos., Tan., Cot., as given at top with the degrees shown at top (whether right or left) ; use headings for Cos., Sin., Tan., Cot., as given at bottom with the degrees given at bottom (whether right or left). The difference for 1 second is given for every minute, and is to be multiplied by the number of seconds and the result added or subtracted.

For very small angles up to 5°, where results precise for the nearest second are required, Table XIV should be used.

TABLE XIV. Auxiliary Table for Logarithmic Sines and Tangents of Small Angles.

This table is computed upon the basis (approximately true) that the sines of small angles, or the tangents of small angles, are proportional to the angles themselves.

Example. Required log sin 0° 47′ 12″.

Then
$$\frac{\sin 47' \, 12''}{\sin 47'} = \frac{47' \, 12''}{47'}$$

$$\sin 47' \, 12' = 47' \, 12'' \frac{\sin 47'}{47'} = 2832'' \frac{\sin 47'}{2820''}$$

$$\begin{array}{lrl} \log \sin & 47' & = 8.135810 \\ \log & 2820'' & = \underline{3.450249} \\ & & 4.685561 \\ \log & 2832'' & = \underline{3.452093} \\ \log \sin & 47'12'' & = 8.137654 \end{array}$$

This auxiliary table gives for 47′, shown in the example above, the value of log sin 47′ − log 2820″ = 4.685561 as appears above, and for each minute in similar fashion ; the number given in the table, then, is to be added to the log of the required angle (given in seconds). It should be noted that the table gives the value of every minute in seconds. As above 47′ = 2820″ ; whence also 47′ 12″ = 2832″.

Example. Required angle whose log sin = 8.325327.
Log sin $1^\circ 13'$ is the nearest (Table XIII).

Required log sin	= 8.325327
Table XIV (sin) $1^\circ 13'$	= 4.685542
$4363''$ log	= 3.639785
or $1^\circ 12' 43''$	= required angle.

Example. Required log sin $3^\circ 19' 34''$.

Table XIV. value for $3^\circ 19'$ (sin)	= 4.685332
$3^\circ 20'$	= 4.685330
Interpolate tabular value for $3^\circ 19' 34''$	= 4.685331
Then log $11974''$	= 4.078239
log sin $3^\circ 19' 34''$	= 8.763570

TABLE XV. Logarithmic Versed Sines and External Secants.
No explanation appears necessary.

TABLE XVI. It may be shown that vers $A = 2\sin^2 \frac{1}{2} A$; it follows that for small angles it is approximately true that the versines of angles vary as the squares of the angles. The external secants also vary as the squares of the angles.

Example. $$\frac{\text{vers } 0^\circ 41' 17''}{\text{vers } 0^\circ 41'} = \frac{(0^\circ 41' 17'')^2}{(0^\circ 41')^2} = \frac{2477^2}{2460^2}$$

$$\text{vers } 0^\circ 41' 17'' = 2477^2 \frac{\text{vers } 0^\circ 41'}{2460^2}$$

The tabular number for $0^\circ 41'$ = log vers $0^\circ 41'$ − log 2460^2.

	= 9.070115
2 log 2477 = 3.393926 × 2	= 6.787852
log vers $0^\circ 41' 17''$	= 5.857967

Example. Required angle whose log vers = 6.309065.
Log vers $1^\circ 9'$ is the nearest (Table XV.).

Required log vers	= 6.309065
Table XVI (vers) $1^\circ 9'$	= 9.070105
	7.238960(2
$4164''$ log	= 3.619480
or $1^\circ 09' 24''$	= required angle

Similarly for external secants of small angles.

For exsec. of 90° − small angles, it may be shown that

$$\text{exsec}\,A = \frac{\text{vers}\,A}{\cos A}$$

$$\text{exsec}\,90^\circ - A = \frac{\text{vers}\,90^\circ - A}{\cos 90^\circ - A} = \frac{\text{vers}\,90^\circ - A}{\sin A}$$

where sin A may be taken from auxiliary tables.

TABLE XVII. Natural Sines and Cosines.

TABLE XVIII. Natural Tangents and Cotangents.

Use the minutes at the left with the degrees at the top, and the minutes on the right with the degrees at the bottom.

TABLE XIX. Natural Versed Sines and External Secants.

This requires no explanation.

TABLE XX. Lengths of Circular Arcs; Radius = 1.

To find the arc for a given angle and given radius, look out the tabular number for the given degrees, also for the minutes, also for the seconds. Add these together and multiply by the radius. The result will be the length of arc.

TABLE XX A. Difference between Circular Arcs and Chords.

The table shows values for radius = 1. For any central angle, the tabular number is to be multiplied by the radius.

TABLE XXI. Squares, Cubes, Square Roots, Cube Roots, and Reciprocals.

This requires no explanation.

TABLE XXII. Turnouts and Switches.

The Frog Angles and Angles of Crotch Frog are good for any kind of turnout. The lead and length of switch rail are computed for Stub Switch only.

TABLE XXII A. / XXII B. Turnouts for Split Switches.

These tables are the standard tables of recommended practice of the Am. Ry. Eng. Ass'n. The combinations of frogs with switches shown in the table are a part of the standard recommended.

The table explains itself otherwise.

Table XXIII. Velocity Heights.

These are computed by the formula $H = 0.0355\ V^2$ which includes the effect due to the rotative energy of the wheels.

Table XXIV. Rise per Mile Various Grades.

Table XXV. Elevation of Outer Rail on Curves.

This table is based on the formula $e = \dfrac{gv^2D}{32.16 \times 5729.65}$

where $g = 4'8\frac{1}{2}''$

Table XXVI. Inches in Decimals of a Foot.

This table requires no special explanation.

Table XXVII. Middle Ordinate for Curving Rails.

This table gives in common fractions of an inch the middle ordinate for various lengths of rails. This will be more convenient for use than it would be if decimal fractions were to be used.

Table XXVIII. Stadia Reductions, Horizontal and Vertical.

Stadia hairs are set so that the horizontal distance with the line of sight level will be 100 times the rod reading, or $100\,r$.

To this, however, must be added a constant c, due to the optical construction of the instrument. It is common practice to assume that $c = 1$ ft. for transits, and $c = 2$ ft. for alidades. For a level sight the horizontal distance will be $100\,r + 1$ for transit, and this distance $100\,r + 1$ is also used in computing vertical heights, when a vertical angle has been taken.

Example. Rod reading = 5.27 at $7°37'$; $c = 1$

$100\,r + 1 = 528$ for a transit

Vertical height from Table for rod reading of 1 ft. = 13.14

For rod reading 5.27 use corrected value $5.28 \times 13.14 = 69.4$

For horizontal correction, interpolate for 528 and for $7°37'$ to nearest foot = 9

$100\,r + 1 = \underline{528}$

Horizontal distance = 519

TABLE XXIX. Mean refraction in Declination.

This table is copied from W. and L. E. Gurley's Manual by permission. The hour angle indicates the distance of the sun from the meridian; for example, 2 hours indicates either 10 A.M. or 2 P.M. For one hour either before or after noon the refraction may properly be taken the same as at noon, or 0 h.

Declinations north appear as + in the table, and the refraction is to be added. Similarly, declinations south appear as −, and refractions are to be subtracted. The refractions here given are to be applied to declinations taken from the Nautical Almanac, and a sufficient record of these must be made before going into the field.

Example. Required corrected declinations Monday, Sept. 11, 1905, at New Orleans. (Lat. 29° 57′ 46″; Long. $6^h\ 00^m\ 13.9^s$.)

Greenwich Mean Noon = 6 A.M. New Orleans (standard time).

Naut. Alm. gives Decl. N. or + 4° 43 16″, Diff. for 1 hour = 0′ 57″ (subtract).

New Orleans	Declination		Lat. 30° Decl. + 5° Refraction		
6 A.M.	+ 4° 43′ 16″				for 5^h = 1′ 52″
	− 57″				4^h = 0′ 52″
7	4° 42′ 19″	+	1′ 52″	=	4° 44′ 11″
	57″				
8	4° 41′ 22″	+	0′ 52″	=	4° 42′ 14″
9	4° 40′ 25″	+	0′ 39″	=	4° 41′ 04″
10	4° 39′ 28″	+	0′ 31″	=	4° 39′ 59
11 A.M.	4° 38′ 31″	+	0′ 27″	=	4° 38′ 58′
12 M.	4° 37′ 34″	+	0′ 27″	=	4° 38′ 01″
1 P.M.	4° 36′ 37″	+	0′ 27″	=	4° 37′ 04″
2	4° 35 40″	+	0′ 31″	=	4° 36′ 11″
3	4° 34′ 43″	+	0′ 39″	=	4° 35′ 22″
4	4° 33′ 46″	+	0′ 52″	=	4° 34′ 38″
5	4° 32′ 49″	+	1′ 52″	=	4° 34′ 41″

Example. Required corrected declinations Monday, Feb. 6, 1905, at Denver. (Lat. 39° 45′ 00″; Long. $6^h\,59^m\,58.2^s$.)

Greenwich Mean Noon = 5 A.M. Denver (standard time).

Decl. S. or − 15° 43′ 46″ Diff. for 1 hour = 0′ 46″ (subtract).

Denver	Declination		Lat. 40° Decl. − 15° Refraction		
5 A.M.	− 15° 43′ 46″				for 5^h = 25′ 18″ (not suitable to use)
	46″				
6	15° 43′ 00″				for 4^h = 3′ 21″
	46″				for 3^h = 2′ 02″
7	15° 42′ 14″				
8	15° 41′ 28″	−	3′ 21″	=	15° 38′ 07″
9	15° 40′ 42″	−	2′ 02″	=	15° 38′ 40″
10	15° 39′ 56″	−	1′ 35″	=	15° 38′ 21″
11 A.M.	15° 39′ 10″	−	1′ 21″	=	15° 37′ 49″
12 M.	15° 38′ 24″	−	1′ 21″	=	15° 37′ 03″
1 P.M.	15° 37′ 38″	−	1′ 21″	=	15° 36′ 17″
2	15° 36′ 52″	−	1′ 35″	=	15° 35′ 17″
3	15° 36′ 06″	−	2′ 02″	=	15° 34′ 04″
4	15° 35′ 20″	−	3′ 21″	=	15° 31′ 59″

TABLE XXX. Triangular Prisms.

Any end area of a section of earthwork may be divided into a number of areas, each triangular in form. This table gives the solidity in cubic yards of a triangular prism 50 feet in length, the factors required for the table being the height or altitude a and the width or base B, in accordance with the formula $S = \frac{50}{54}\,aB$. The end area solidity for 100 feet in length, due to two different end sections, will be the sum of the two solidities for the end sections, or

$$V_{e100} = S_0 + S_1$$

Example.	Sta. 1	$\frac{15.7}{-5.8}$	-7.4	$\frac{19.6}{-8.4}$
Base 14 ft. Slope $1\frac{1}{2}$ to 1	0	$\frac{12.7}{-3.8}$	-3.5	$\frac{14.2}{-4.8}$

For Sta. 0 the calculation may be put in the form

$$S_0 = \tfrac{50}{54}(3.5 \times \overline{12.7 + 14.2}) + \tfrac{50}{54}(7.0 \times \overline{3.8 + 4.8})$$
$$= \tfrac{50}{54}(3.5 \times 26.9) \qquad + \tfrac{50}{54}(7.0 \times 8.6)$$

where the triangles are grouped in pairs, in which there is a common base for the two triangles in any pair.

Since the table is in the form $S = \frac{50}{54}\, aB$ the solidity for 20 will be 10 times that for 2, and the solidity for $\frac{2}{10}$ will be $\frac{1}{10}$ that for 2. The use of the table is then simple.

For instance, to find $\frac{50}{54}(19.3 \times 24.7)$, find

from Table XXX.	19.3	20.	$= 357.4$
		4.	$= 71.5$
		.7	$= 12.5$
		S	$= 441.4$

In the example given by notes above,

$$S_0 = \tfrac{50}{54}(3.5 \times 26.9) + \tfrac{50}{54}(7.0 \times 8.6)$$

from Table XXX.	26.9	3. =	74.7		
		.5	12.5	87.2	
	8.6	7.		55.7	142.9

$$S_1 = \tfrac{50}{54}(7.4 \times 35.3) + \tfrac{50}{54}(7.0 \times 14.2)$$

from Table XXX.	35.3	7. =	228.8		
		.4 =	13.1	241.9	
	14.2	7. =		92.0	333.9
	$V_{100} = S_0 + S_1 =$				476.8

If the section be 80 feet long instead of 100, the correct result will be $476.8 \times 0.8 = 381.44$, and for any length in direct proportion.

Irregular sections of earthwork may also be divided into pairs of triangles, and each pair calculated for 50 feet in length by $S = \frac{50}{54}aB$. If divided into trapezoids the computation may still be put in the form $S = \frac{50}{54}aB$. In both these cases this table evidently applies.

Where speed is desired, each quantity may be taken from the table to the nearest yard only, and two or more parts added by mental arithmetic. The precision thus secured is generally superior to that of the field measurements, where a difference of 0.1 foot in the height of any cut or fill means, commonly, several yards difference in solidity.

TABLE XXXI. Prismoidal Correction.

This table gives the correction to be applied to the "end area" solidity to secure a result strictly correct by prismoidal formula. The table gives values for $C = \frac{1}{3.24}(c_1 - c_0)(D_1 - D_0)$. In this table also the correction for 20 will be 10 times that for 2, and the correction for $\frac{2}{10}$ will be $\frac{1}{10}$ that for 2.

Example. Use data given above for Table XXX (top p. 280). The correction will be

$$C = \frac{1}{3.24}(7.4 - 3.5)(\overline{19.6 + 15.7} - \overline{14.2 + 12.7})$$

$$\doteq \frac{1}{3.24}(3.9)(35.3 - 26.9)$$

$$= \frac{1}{3.24}(3.9)(8.4)$$

from Table XXXI. 3.9 8. = 9.63

.4 = .48

10.11

From Example Table XXX. $V_{e100} = 476.8$

from above $C = 10.1$

Correct Solidity $= V_{p100} = 466.7$

If the section be 80 feet long instead of 100, the correct result will be $466.7 \times 0.8 = 373.36$ and for any length in direct proportion.

The multiplication by 0.8 can best be made, as just above, *after applying the correction.*

TABLE XXXII. Earthwork for various bases and for slope 1½ to 1.

It applies only to regular "Three Level Sections." Each table gives for any center height two quantities under columns L or K. Column L gives the solidity in cubic yards of a level section 50 feet in length and of the given center height. Column K gives a quantity to be used in connection with the side heights. The figure from column K is to be multiplied by the difference between (*a*) the sum of the side heights, and (*b*) twice the center height, or $K(h_r + h_l - 2c)$ and the result is to be added or subtracted depending upon whether the arithmetical sum of the side heights is greater or less than twice the center height.

Example. Sta. 1 $\dfrac{15.7}{-5.8} - 7.4\ \dfrac{19.6}{-8.4}$

Base 14 feet
Slope 1½ to 1 0 $\dfrac{12.7}{-3.8} - 3.5\ \dfrac{14.2}{-4.8}$

Sta. 0	3.5 $L =$ 124.8	$K =$ 11.3	3.8 $= h_l$
	18.1	1.6	4.8 $= h_r$
	142.9	678	8.6
		113	7.0 $= 2c$
		18.08	1.6
Sta. 1	7.4 $L =$ 344.0	$K =$ 16.8	5.8
	− 10.1	− 0.6	8.4
	333.9	− 10.08	14.2
			14.8

$$S_0 = 142.9$$
$$S_1 = 333.9$$
$$V_{100} = 476.8$$

The results agree with those given for Table XXX. where the notes are the same.

300